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ORAL ROENTGENOLOGY

AUTHOR OF

ORAL ANESTHESIA, Local Anesthesia in the Oral Cavity for the Different Branches of Dentistry. 1st and 2d Editions.

ORAL ABSCESSES, A Pathological Study of Infectious Foci in the Mouth and Their Relation to Somatic Diseases.

ORAL ROENTGENOLOGY

A ROENTGEN STUDY OF THE ANATOMY AND PATHOLOGY OF THE ORAL CAVITY

BY

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SECOND EDITION, REVISED AND ENLARGED

WITH FOUR HUNDRED AND SEVENTY ILLUSTRATIONS

LEA & FEBIGER
PHILADELPHIA AND NEW YORK
1922

LEA & FEBIGER,
1922

PRINTED IN U. S. A.

TO THE MEMORY OF MY MOTHER

BERTHA THOMA-SCHILL

BORN AND DIED IN BASEL, SWITZERLAND

THIS VOLUME IS DEDICATED

PREFACE TO THE SECOND EDITION.

SINCE the publication of the first edition of *Oral Roentgenology* in 1917, the Roentgen method has become a well-established means of examination in dentistry and oral surgery. In many instances it is the most important link in the chain of evidence which leads to diagnosis, and frequently it also leads to discovery of the cause of the disease.

There are, however, other important uses of the Roentgen picture. It serves the oral surgeon as a guide when operating, helps the dentist to determine the result of mechanical procedures and the research worker to follow the process of disease, the result of operations and the progress of healing.

The medical practitioner today is as much interested as the dentist in Roentgen examination of the jaws and teeth, since the interrelation of medical diseases and dental infections is generally recognized. The most eminent internists in this country, when making a thorough examination of any patient, include an oral examination by means of the Roentgen ray. The ophthalmologist, the aurist and the laryngologist all have occasion to search in the oral cavity for contributory causes when treating certain diseases which belong to their specialties.

The roentgenologist should have a special knowledge of the normal anatomy of the parts he is examining, he should be familiar with all branches of pathology and should make it his particular study to learn how disease changes the radiability of the tissues. Besides this the dental roentgenologist should be familiar with all the problems of dentistry and with the various methods of diagnosis.

When we consider the important place which the Roentgen method occupies in modern examination, it becomes evident that the practice of this specialty should be reserved for regular dental or medical graduates. In the preface to the first edition the writer lamented the fact

that there was no law prohibiting the most incompetent from taking roentgenograms and furnishing elaborate reports. Since that time such a law has been passed in Pennsylvania, prohibiting the making and interpretation of dental Roentgen pictures by laymen. Practitioners should be discouraged from sending their patients to commercial laboratories, as such a practice lowers the standard of this important specialty and of the dental profession in general, to say nothing of the danger of exposing patients to ignorant diagnosticians.

In the preparation of this edition the text has been almost entirely rewritten. The new terms officially adopted by the American Academy of Periodontology have been used in the section dealing with periodontal diseases, and material from several original articles published by the writer since the first edition, has been drawn upon. Among these is the article "Cysts of the Jaws," from the *Boston Medical and Surgical Journal*, December, 1920, No. 26, vol. clxxxiii; a contribution to the *Medical Clinics of North America*, January, 1918, "The Relation of the Teeth and Jaws to Medicine;" and also an article from *The Journal of the National Dental Association*, May, 1921, "The Use of the Roentgen Ray for Diagnosis of Surgical Diseases of the Mouth." One hundred and sixty new illustrations have been added.

There has been an addition inserted at the beginning of the book, giving an elementary description of Roentgen technic, special attention being paid to the methods of making exposures. This section has been written particularly for the student and beginner, to make the volume useful as a student's text-book. Another section is devoted to the interpretation of roentgenograms. In this part, examples are given of errors which lead to misinterpretation. The third part treats with the Roentgen appearance of the normal tissues of the oral cavity, giving the student, as well as the practitioner, a chance to compare photographs showing the outer and inner make-up of the jaws with the Roentgen picture. In the fourth part, the various diseases which affect the teeth and jaws are taken up according to their classification. Whenever possible, a photograph has been added to show the effects of the disease on the tissue. A large number of practical cases have been used to illustrate the various conditions and

a great many new cases have been added to this section. A history of the case, a conclusion from the Roentgen picture, and a report of operative and pathological findings accompanies most of the pictures. All this has been done with the intention of not only showing pictures, but of giving the reader a more intimate knowledge of the cases. In the fifth part, the use of Roentgen pictures as an aid in treatment has been taken up and the illustrations have been chosen with the idea of making the section a practical help. The last section describes, principally, the use of the Roentgen ray for examination of the oral tissue, for determining foci of infection in somatic disease and for the investigation for causes of dental and trigeminal neuralgia. On account of the importance of these investigations they have been made a special feature.

Almost all of the photographs and Roentgen pictures are original. A few of the cases were referred to the writer for Roentgen examination only, but the majority received surgical treatment, which made it possible, after taking the Roentgen picture, to study the condition during the operation and, when advantageous, to make a pathological investigation.

As in the first edition the reproduction of all the Roentgen pictures in the negative has been strictly adhered to. The writer considers prints from the negatives practically worthless, since they fall short of their purpose of familiarizing the student and beginner with the appearance of the various tissues in the negatives used in general practice.

A number of special contributions have been gratefully received and have been acknowledged under the description of the case. The writer wishes to acknowledge here his gratitude to all his professional friends who have contributed indirectly to this book by referring the patients whose roentgenograms have been used.

Finally, the writer is indebted to the publishers for their interest and excellent typographical execution and their care in the intricate task of reproducing the roentgenograms.

KURT H. THOMA.

43 BAY STATE ROAD,
BOSTON, MASSACHUSETTS.
1922

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ORAL ROENTGENOLOGY.

PART I.

ROENTGEN TECHNIC.

I. NOMENCLATURE.

THERE are a great many Roentgen terms in use and there has, so far, been no standardization in dental literature. In this book the terms employed are those which were adopted by the American Roentgen Ray Society on October 1, 1913, and accepted by the *Journal of the American Medical Association*. The Committee on Nomenclature of the American Institute of Dental Teachers also recommends their use.

ROENTGEN RAY. A ray discovered and described by Wilhelm Conrad Roentgen.

ROENTGENOLOGY. The study and practice of the Roentgen ray, as applied to medical science.

ROENTGENOLOGIST. One skilled in roentgenology.

ROENTGENOGRAM. A shadow picture produced by the Roentgen ray on a sensitive plate or film.

ROENTGENOGRAPH (Verb). To make a roentgenogram.

ROENTGENOGRAPHY. The art of making roentgenograms.

ROENTGEN DIAGNOSIS. A diagnosis made by means of roentgenograms.

In addition to these terms the following words have been made use of, the three latter having been supplied by Dr. Ottolengui[1] to fulfill a long-felt need for adequately expressing certain properties:

RADIABILITY. The property of an object to transmit the Roentgen ray.

RADIOPARENT. RADIOPARENCY. } Offering no barrier to the Roentgen ray.

RADIOLUCENT. RADIOLUCENCY. } Offering slight resistance to the Roentgen ray.

RADIOPAQUE. RADIOPACITY. } Impervious to the Roentgen ray.

II. PRODUCTION OF ROENTGEN RAYS.

Roentgen rays were first discovered by Wilhelm Conrad Roentgen in 1895. Not knowing what they really were he used the algebraic symbol for the unknown and called them *x*-rays. The *x*-rays or Roentgen rays are produced by conducting a high tension electric current through a Roentgen tube. This high tension current is generated by means of a Roentgen machine.

Roentgen Machines.—There are many different kinds of these machines in the market. According to the principle used to produce the high tension current they may be classified as induction coils or interrupterless transformers.

Induction Coil Type of Roentgen Machine.—The ordinary street current is transformed into a high voltage or high tension current by means of an induction coil. This is made up of a soft iron core with a primary winding of coarse wire. The primary winding is well covered by an insulating layer, usually consisting of a tube made of mica, rubber, etc., on which is wound the secondary winding. This consists of many layers of well insulated fine copper wire. Defects in the insulation of these wires and the insulation between the layers lowers the efficiency of the apparatus.

The capacity of the coil is measured by the number of inches representing the largest distance which the induced current is able to

[1] Editorial: Items of Interest, February, 1917, p. 141.

jump by means of a spark. So we speak of a ten-inch or twelve-inch coil. Induction coils suitable for Roentgen work produce as much as 120,000 volts. The current strength, however, is decreased proportionately, the output being from 5 to 30 milliampères.

Interrupter.—The secondary, or induced current, is made by producing and breaking the primary current. The make and break should be regular, complete and rapid. Various interrupters have been devised for this purpose. There are mechanical interrupters, the simplest type being the vibrator. The mercury interrupters of the dip and centrifugal type have the disadvantage that the mercury has to be cleansed from time to time. Electrolytic interrupters are best suited for Roentgen work because they are simple, easily regulated and give a high rate of interruption. There are various forms of the latter, of which the general action is as follows: When the primary current passes through the interrupter a bubble of gas is formed at the anode, which interrupts the current. The bubble soon becomes dispersed and the current is allowed to pass again. The disadvantages of the electrolytic interrupter are formation of disagreeable fumes, noisy action and a tendency to overheat when used too long at a time.

Valve Tube.—Inverse currents are often produced in the secondary circuit, especially with the electrolytic interrupters. These are undesirable for Roentgen work and methods, therefore, have been devised to prevent them from passing through the Roentgen tube. The valve tube, of which various types have been constructed, is used for this purpose. It is a tube with a low vacuum, containing a small and a large electrode, so as to furnish marked resistance to the passing of the current in the wrong direction. The vacuum of the valve tube has to be regulated like that in a Roentgen tube.

Rectifier.—Induction coils are best adapted for direct current. If an alternating current only is available it is necessary to use a mechanical, or electrolytic, rectifier to change the alternating current into a current with stable polarity. It would be of advantage not to use an induction coil at all, but an interrupterless transformer.

Rheostat.—The secondary current can be regulated indirectly by means of a rheostat inserted in the primary circuit.

Meters.—The milliampère meter should be installed in series in the secondary circuit; the volt meter is connected in parallel. The following diagram shows the connection of an induction coil outfit (Figure 1).

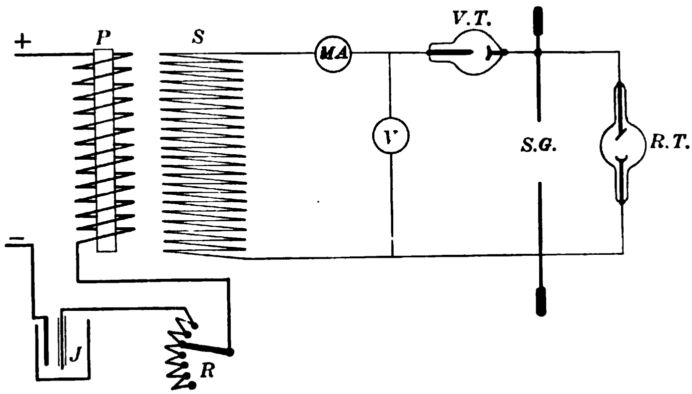


FIGURE 1.

Diagram of Induction Coil Machine. *P.*, primary coil; *S.*, secondary coil; *M.A.*, milliampère meter; *V.*, volt meter; *V.T.*, valve tube; *S.G.*, spark gap; *R.T.*, Roentgen tube; *I*, interrupter; *R.*, rheostat.

Interrupterless Transformer. — This is the most efficient type of Roentgen apparatus, and is especially adapted for alternating current. When used for direct current it is necessary to employ a rotary converter to change the direct current into alternating. The machines consist of the following parts:

1. *For direct current—rotary converter.*
   For alternating current—synchronous motor.
2. Transformer.
3. Commutator or rectifier.
4. Rheostat.
5. Meters.
6. Switches.

Rotary Converter.—This, as already mentioned, is used when direct current (D. C.) only is available (Figure 2). The street current is utilized to set in motion a D. C. motor, which is used to turn the armature of an alternating current (A. C.) dynamo. Instead of

having two separate machines they may be enclosed in one casing, when it is called a rotary converter. The direct street current is transformed by this converter into a low tension alternating current.

Transformer.—The alternating current, supplied from the street or produced by the rotary converter, is passed into the transformer. This is of the closed core magnetic circuit type, usually with the primary winding on one arm and the secondary on the other, the whole transformer often being immersed in oil. The primary winding may be tapped at various places so that the current can be passed through one-quarter, one-half, three-quarters or the entire winding. This, of course, alters the inductance proportionately. The high tension current produced in the secondary winding of the transformer is of the alternating type, and to be used for the production of Roentgen rays it has to be changed. This is done by means of the rectifier, or commutator.

Commutator.—Its function is to change the high tension alternating current into high tension direct current. It should be mounted on the shaft of the rotary converter, or in alternating current machines on the shaft of a special motor (Figure 3). The commutator must be correctly adjusted to the cycles of the alternating current. It must be in absolute synchronism.

The Rheostat.—The rheostat is used to change the voltage of the street current and with it, of course, the voltage of the high tension current in the secondary circuit. It is generally inserted in the line supply.

Meters.—A kilowatt meter is used to measure the quantity of primary current used. The milliampère meter is used in the secondary circuit; also the volt meter, which is connected in parallel, both for reading of the induced current.

Switches.—The main switch usually controls the street current and starts the machine. Another switch throws the high tension current into the terminals.

The efficiency of a transformer is much greater than that of a coil, as there is less power lost. The efficiency of a coil is from 50 to 75 per cent, while in transformers it may be as high as 95 per cent and

should never be below 90 per cent. For Roentgen purposes transformers should be so constructed that voltages from 30,000 to 120,000 can be obtained. The more powerful a machine the higher the milli-

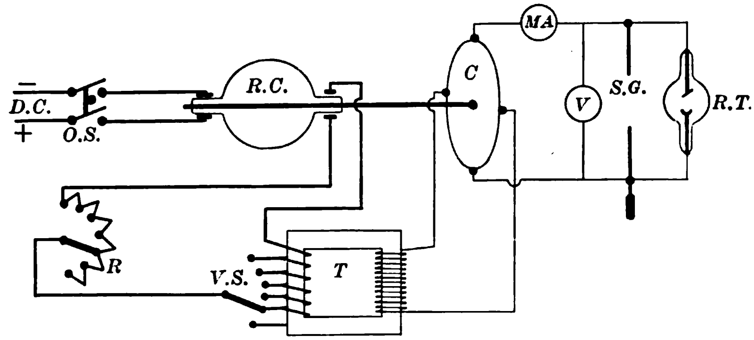


FIGURE 2.

Diagram of Direct Current Interrupterless Machine. *D.C.*, direct current; *O.S.*, operating switch; *R.C.*, rotary converter; *C.*, commutator; *M.A.*, milliampère meter; *V.*, volt meter; *S.G.*, spark gap; *R.T.*, Roentgen tube; *R.*, rheostat; *V.S.*, voltage switch; *T.*, transformer.

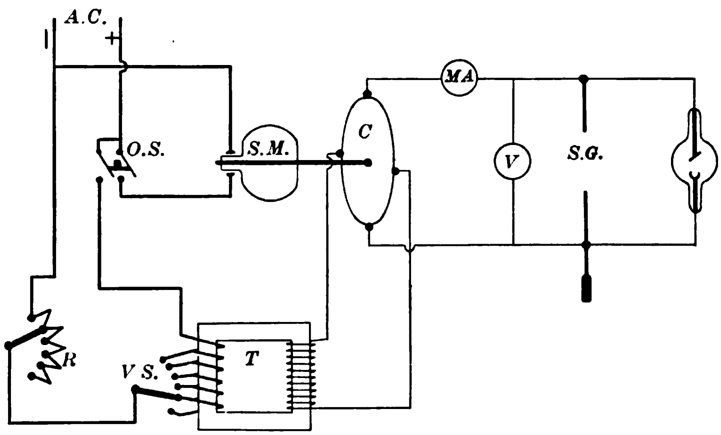


FIGURE 3.

Diagram of Alternating Current Interrupterless Machine. *A.C.*, alternating current; *O.S.*, operating switch; *S.M.*, synchronous motor; *C.*, commutator; *M.A.*, milliampère meter; *V.*, volt meter; *S.G.*, spark gap; *R.*, rheostat; *V.S.*, voltage switch; *T.*, transformer.

ampèrage which can be produced, the voltage remaining the same. We speak of 4 to 6 kilowatt machines, the energy being measured in kilowatts. (Energy [kilowatts] = volts × milliampèrage.)

Special Dental Roentgen Machines.—Small, compact machines of the coil and transformer type have been constructed by various firms to conform to the special requirements of the dentist. In a general way one may say that the dental machine is constructed so that it may be easily moved from one place to another. Its capacity is limited to the power needed to take dental roentgenograms and some machines have only power enough to take intraoral pictures. More recently, with gas tubes almost entirely replaced by Coolidge tubes, the special Coolidge units have been constructed. Some of these are designed so that their performance is standardized, eliminating the necessity of regulating and testing, which simplifies the armature and manipulation. The voltage and, therefore, also the penetration is fixed as required for the best results in dental work. The machine can be used with uniform results without any knowledge of the laws of electricity. There are various sizes of Coolidge tubes used with these machines, a description of which will be found under a separate heading. The decrease in the size of the tube and the short cone make it possible to shorten the target distance considerably, and the target distance, as will be seen later under the heading "time of exposure," has a great influence on the milliampères required to get a picture, or the number of seconds required for an exposure. Either of these two factors has to be increased in proportion to the square of the increase in the distance.

While these small machines have many advantages for the general practitioner of dentistry, on account of their simplicity and stability and because they are practically "fool proof," they do not generally allow the use of different styles of tubes, nor changes in milliampèrage and penetration, such as is required for sinus work, or for the best results in extraoral roentgenograms.

Tube Stands and Accessories.—Special tube stands to take dental roentgenograms in sitting position have been so perfected that they can be adjusted to any angle. They should be sufficiently heavy and solid to prevent the tube from vibrating during the exposure. The same tube stand may be used for extraoral Roentgen pictures and sinus plates. The accessories consist of a lead-glass shield and a lead-

rubber cap, which completely enclose the tube and keep the rays from radiating into the room. A cone is used through which the rays are allowed to pass toward the patient.

Roentgen Tubes.—Two principal types are now in use, the gas and Coolidge tubes.

Gas Tubes.—Gas tubes consist of a glass bulb with a cylindrical extension on each side. One of these contains the cathode, the other the anode. The cathode is of aluminum and is concave, which causes the cathode stream to come to a focus. This stream is produced when the high frequency current is allowed to pass through the tube.

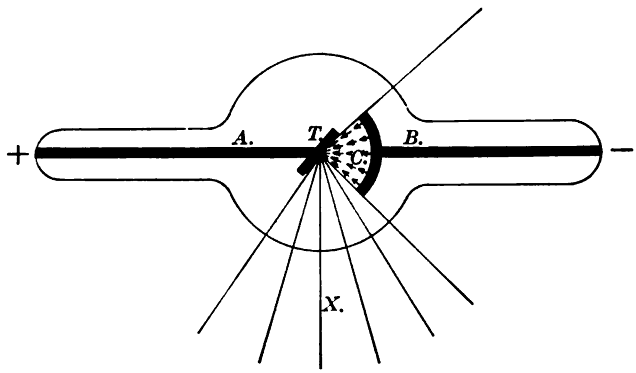


FIGURE 4.
Diagram of Roentgen Tube in Operation. *A.*, anode; *B.*, cathode; *T.*, target; *C.*, cathode stream; *X*, *x*-rays.

The electric current passes, of course, from the anode to the cathode, while the cathode stream moves in the opposite direction (Figure 4). The anode, also called anticathode, is placed directly in the path of the cathode stream and, therefore, is called the target. The target surface is placed at an angle of 45 degrees to the direction of the cathode stream. As great heat is generated, the target has to be made of very high-fusing metal. Platinum is suitable, but tungsten is generally used, a thin disk being attached to the surface of the anode. The remainder of the anode head is made of copper, which is the best heat conductor. Special devices to conduct the heat to the outside of the tube, and radiator devices for its disposal are used by some

manufacturers. The relation of the cathode to the target is of great importance, as it determines the size of focus and the quality of the generated Roentgen rays (Figure 15).

Over the anode is another projection with a metal electrode. This is the assistant anode, which is used in the pumping of the tube (Figure 5).

A regulating device contained in an accessory chamber is one of the most important parts. The Roentgen tube is pumped to a certain vacuum, which is less than $\frac{1}{1000000}$ of an atmosphere. For practical reasons the vacuum is made somewhat higher than required. The regulating chamber contains asbestos, impregnated with a sub-

FIGURE 5.
Gas Tube.

stance which liberates gas when an electric current is passed through. The gas escapes into the tube and the vacuum becomes less perfect. When the tube is at rest these gases are again taken up and the vacuum returns to the original degree. Great care must be taken not to lower the vacuum too much, either by the use of the regulating device (by a method described later), or by overheating the target during exposure, as under certain conditions the liberated gases are not reabsorbed and, as a result, the vacuum remains too low.

Gas tubes often become freakish, especially if not carefully seasoned. They may fail to go back to the original vacuum, remain unsteady during the exposure and sometimes sputter. This is thought to be

due principally to the disintegration of the cathode metal, caused by the action of the gases in the tube. As the tubes are pumped from ordinary atmospheric pressure the content remains of the same composition as air, containing nitrogen, oxygen and a small percentage of carbon dioxide, hydrogen, argon, neon, etc. The presence of all these gases, with the exception of nitrogen and hydrogen, becomes distinctly deleterious to the working of the tubes. They contribute to the possibility of tubes becoming freakish and of their getting soft when heated during the exposure.

To overcome these conditions, tubes have been manufactured which contain a residual vacuum of other gases than the mixture of air.

The Hydrogen Tube.—The hydrogen tube (Figure 6), manufactured by the Victor Electric Corporation, contains hydrogen gas. It has special devices by which the vacuum can either be lowered or raised.

FIGURE 6.
Hydrogen Tube.

The Helium Tube.—This is manufactured by the Victor Electric Corporation (Figure 7). It contains a gas which has no deleterious effect, even if the target is run red hot in ordinary use. The manufacturers claim that the vacuum will not drop during the exposure and if reduced purposely it will, after a short time, recover. A new type of regulator is used, which gives off relatively inert gas, contributing to the stability of the vacuum.

The NitroKen Tube.—The NitroKen tube, manufactured by the Wappler Electric Company, shows marked improvements over the ordinary gas tube (Figure 8). The residual vacuum consists only of

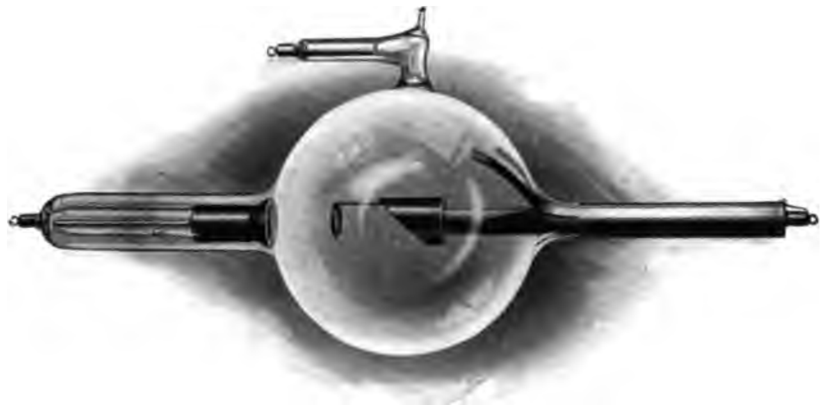


FIGURE 7.
Helium Tube.

attenuated nitrogen and the substance used as a reducer in the reducing chamber causes liberation of pure nitrogen when the current is passed through. This gas shows a minimum of chemical affinity toward

FIGURE 8.
NitroKen Tube.

metal. The tubes, therefore, will not become freakish even if the electrodes get very hot, and the vacuum will remain constant. The operation of the tube is simple, but the vacuum must be carefully

adjusted before making an exposure. The regulating substance will not be exhausted for at least a year. During the intervals between exposures the tube has a tendency to return to a high degree of vacuum, which has the advantage that the same tube, by proper adjustment before each exposure, can be used for any desired penetration. The metal parts of the regulator are said to be so designed that over-reduction of the vacuum is impossible.

FIGURE 9.
Coolidge Tube.

Coolidge Tubes.—The Coolidge tube is constructed on an entirely different principle (Figure 9). The vacuum is very much lower, the exhaustion of the tube being one thousand times greater than in the

FIGURE 10.
Spiral Cathode in Coolidge Tube.

ordinary gas tube. This vacuum is not changed for the purpose of changing the penetrating quality of the Roentgen rays. The adjustment is made by a special feature of the cathode, which consists of a spiral made of tungsten wire (Figure 10). This is mounted within

a cylindrical tube, which serves to focus the cathode stream. No current will pass through a tube if the cathode is cold. A low tension current (6 ampères and 12 volts) is used to heat the filament in the cathode. This may be obtained from a battery or, better still, from a step-down transformer for alternating current, which can be taken from the main or rotary converter. Two wires, therefore, lead through the cathode terminal to the tungsten filament. The number of milliampères which can be sent through the tube depends upon the degree of temperature to which the cathode is heated. A rheostat is used to produce the change in the circuit, which affects the temperature of the cathode. The circuit and connections of the Coolidge tube are shown in Figure 12.

FIGURE 11.
Anode with Cooling Device.

The anode is used as the target in the Coolidge tube and is constructed along the same lines as in a gas tube. It consists of a single piece of wrought tungsten attached to a molybdenum rod, which is supported by a split iron tube. It is perfectly safe to use the tube with the target at white heat as long as the energy is not so high that the tungsten melts. Special cooling devices are often connected with the cathode terminal (Figure 11).

The milliampèrage passed through the tube depends entirely on the temperature of the filament. At a certain temperature not more than a given number of milliampères can pass through the tube, regardless of how much the output from the machine is. The penetration increases as the voltage is increased above that needed for the current value.

The universal Coolidge tube is seven inches in diameter, while smaller dental tubes are usually three and three-quarters inches in diameter. They have attached, on the anode side, a cooling device, usually consisting of a series of metal disks, from which the heat generated during the exposure is given off by radiation. Such tubes are made for a three- or five-inch spark gap back-up and for currents from 10 to 30 milliampères. The anode and cathode may be at right angles (Figure 13), or as in the larger tubes, opposite each other.

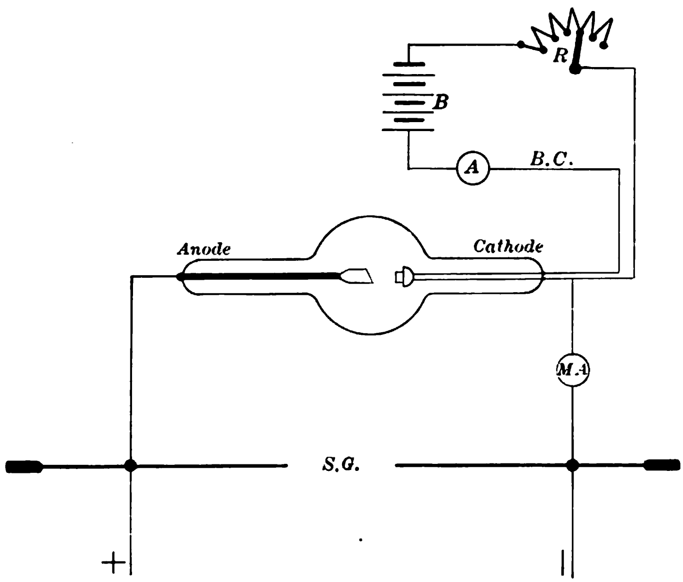


FIGURE 12.
Diagram of Coolidge Tube Circuit. *B.*, battery; *B.C.*, battery current; *A.*, ampère meter; *R.*, rheostat; *M.A.*, milliampère meter; *S.G.*, spark gap.

Roentgen tubes are also made with fine, medium and broad focus. The finer the focal spot the less is the capacity of the tube. For a fine focus not more than 25 milliampères, for a medium 50, and for a broad focus not more than 80 milliampères should be used with a spark back-up of 6″, or else the target will become damaged. The finer the focus the sharper is the definition of detail in the Roentgen picture.

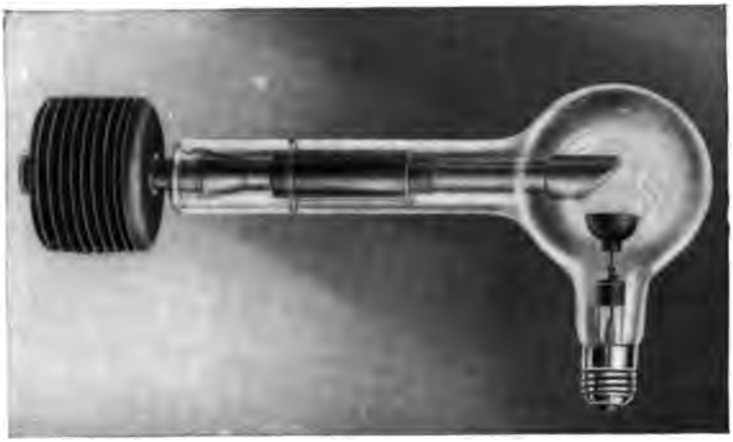


FIGURE 13.
Small Dental Coolidge Tube. (Anode and cathode at right angles.)

FIGURE 14.
Small Dental Coolidge Tube.

Small bulbed Coolidge tubes of various sizes are constructed for special use with portable machines and small dental outfits. Their smaller size decreases the target distance and, therefore, also the necessary power of the machine and time of exposure (Figure 14).

The cathode can be constructed so that the electrons all strike the target on a small area (Figure 15). This area is called the focus, and by changing the distance of the target slightly we can vary the diameter of the focus. On the target, represented by Plane A, we get a very fine focus, about 2 mm. in diameter. If the plane is moved a

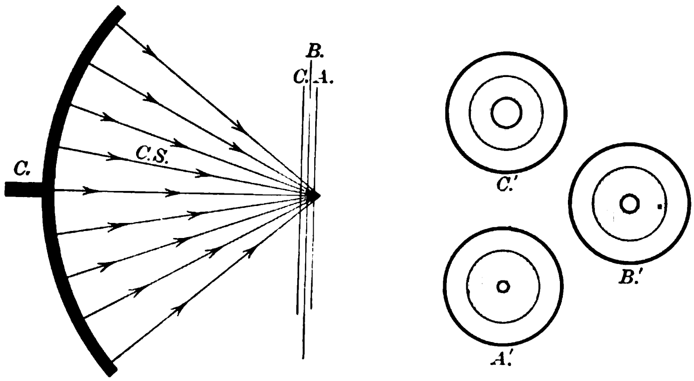


FIGURE 15.

Diagram Showing Focus of Roentgen Tubes. C., cathode; C.S., cathode stream; A.B.C., different target planes; A'., showing fine focal spot of target, Plane A; B'., showing medium focal spot of target, Plane B; C'., showing broad focal spot of target, Plane C.

little nearer to the cathode, Plane B, we get a medium focus, about 2 to 4 mm., and on Plane C we get a broad focus, over 4 mm. in diameter.

The Quality of Roentgen Rays.—The Roentgen rays produced in one tube at the same instant are not all of the same quality. There are soft rays and hard rays, secondary rays and rays produced by inverse currents. Various devices are used to exclude all but the direct rays of penetrating quality. The lead-glass tube shield and lead-rubber cap prevent rays from escaping in all directions, thus protecting the patient and operator from unnecessary exposure, which would occur not only in a direct way, but also indirectly, since the

rays are reflected from the ceiling, walls and other surfaces in the room. The secondary rays given off from the glass of the tube are cut out by the use of a lead diaphragm and a metal cylinder, or cone. The diaphragm is of lead, with a hole of sufficient size to let through the necessary amount of rays for the exposure. The metal cylinder or cone cuts out most secondary rays which have succeeded in passing through the diaphragm. The soft rays are most harmful and may cause dermatitis. To protect the patient from these rays and from the resulting dermatitis an additional safeguard is now in general use. This consists of an aluminum disk covering the hole of the diaphragm, which retains the rays of lower penetrating power.

The quality of the rays also varies according to the vacuum in the tube. A tube with low resistance emits principally soft rays, which give but little penetration and are readily absorbed by the tissue, while a tube with a high resistance, in which the vacuum is more complete, emits hard rays, which easily penetrate even hard tissue. The quality of the rays, therefore, can be changed by changing the vacuum in the tube, and the success of the Roentgen picture depends a great deal upon a thorough understanding of this principle and upon good judgment in its application.

III. APPLICATION OF THE ROENTGEN RAYS.

Protection of Operator.—The danger attending exposure to the Roentgen rays was not known by the pioneers in this work, the need of caution and methods of protection only having been discovered after the very sad experiences of many of the original investigators. These founders of a new and great science, which has become one of the most important specialties of medicine, have paid a heavy toll, by the loss of fingers, arms, hands and in some instances, even their lives.

Today there is little danger if proper methods of protection are employed. The use of the lead-glass shield and leaded-rubber cap enclosing the tube prevent, in an effective manner, the escape of rays other than through the cone. However, as the rays used for the exposure are not all stopped by the part of the patient subjected to

them, the operator should protect himself from them, as well as from the secondary and tertiary rays reflected from the ceiling, walls and floor. This may be effected by standing behind a lead shield with lead glass for observation or, better still, by making the exposure from outside the room, behind a partition or door lined with sheet lead of sufficient thickness to render it absolutely impervious to the rays. A small window may be fitted with lead glass to enable the operator to observe the exposure and the patient.

Under no circumstances should the operator or his assistant hold the films or plates during the exposure. The patient should always be directed to do this, as the effects are accumulative. It is a good plan to make a test from time to time to find out whether the protection is sufficient and carefully enough observed. This is easily accomplished by putting into one's waistcoat pocket a package of dental films with two coins, one on each side of the film. After a few days, develop the film and if the outline of the coin is discernible it is, of course, evident that the protection is insufficient.

Protection of the Patient.—Some accessories to protect the patient have already been described. The lead-glass shield and cap are also for the patient's safety, as well as the metal cone and filter, which eliminate the secondary and injurious soft rays generated in the best of tubes. Undoubtedly there is much less danger from exposing the patient to the rays produced by the modern powerful machines and perfected tubes than to those generated by older apparatuses, and the time of exposure has been reduced to a very safe period. The possibility of harm is, of course, much greater when a thick part with dense bone has to be penetrated, such as the head, for sinus pictures. With the introduction of the double screen, reducing the time to one or two seconds, we can also make these exposures with safety. It should always be remembered that the effect of the Roentgen rays is cumulative and also that some persons are probably especially sensitive to their action, while others are comparatively immune.

The softer the rays and the nearer the tube is placed to the skin, the greater is the danger. With normal tubes, the safe time of exposure expressed in milliampère seconds, is put down in the following

table as one-half of the quantity which would produce an erythematous reaction of the skin of the face of a middle-aged man. For children the exposure should be decreased and for the aged individual it may be increased. The amount can be used at one sitting or be divided over a period of time, but if the limit is reached no more exposures should be made until three weeks have elapsed.

Distance from target to skin.	Milliampère seconds.
20 inches	2800
16 "	2400
14 "	1800
12 "	1350
10 "	810
8 "	600
6 "	340

A New York physician, Dr. George M. MacKee,[1] reports 8 cases of dermatitis produced by Roentgen examination of the teeth, and states that he is convinced that in all cases the fault lay in the technic. This is a warning which should be carefully considered by everyone who intends to use a Roentgen machine.

Adjustment of Vacuum in the Tube.—The vacuum of the tube determines the necessary penetrating power of the Roentgen ray for taking a picture of a given part of the body. As the radiability decreases the penetration required becomes greater; for bone and dental work, therefore, we need a comparatively high tube. Too much penetration, however, gives a picture with little contrast, which is worthless for making a diagnosis of pathological conditions, some of which cause only slight changes in the radiability of the tissue.

In the ordinary gas tube the vacuum can be changed by letting a weak current pass through the regulating chamber. This generates heat, which in turn produces gases from the chemicals therein. The vacuum then becomes less complete and the tube offers less resistance to the current, increases the milliampèrage at the expense of the voltage and produces softer rays. After a while the gases are again taken up by the chemicals, causing the vacuum to rise; that is, to

[1] Dental Cosmos, 1916, p. 428.

become more perfect. The tube then offers greater resistance to the current, higher voltage is required to force it through, and hard rays of greater penetrating quality are produced. If the vacuum has been lowered too much it can often be brought back to normal by reversing the poles and letting a very weak current pass through the tube for a considerable length of time. If this does not remedy the trouble the tube should be sent to the manufacturer to be repumped.

There are two ways of reducing the vacuum of the tube. The first way is automatic. The movable arm on the regulating chamber (Figure 5) is so adjusted that the distance from its end to the cathode terminal equals the desired spark gap. The spark gap determines the resistance of the tube. If this resistance is greater than that offered by the spark gap of the regulating chamber, part of the current (or if the resistance of the tube is very great the entire current) will pass through the latter channel. This generates gas in the regulating chamber and lowers the vacuum of the tube until the way from anode to cathode offers the least resistance. Therefore, the more the length of the regulating spark gap of the tube is reduced the more we reduce its vacuum. The disadvantage of this method of adjusting the vacuum is that nervous patients are liable to be frightened by the spark jumping so near the face, and if the regulating device is allowed to function during the exposure, involuntary movements of the patient are likely to spoil the picture. In addition, there is danger that the wire leading the current to the cathode may come too close to the regulating lever, causing a short circuit, which may reduce the tube so that it will have to be repumped. To avoid this the regulating wire is nearly always cut off and the tube is regulated in the following manner:

The condition of the tube should be first determined. This may be done in one of three ways. First, by means of the spark gap on the machine. With the machine at its normal working strength, connect the tube and adjust the spark gap on the machine to the desired distance. Then turn the current on for a second. If the spark jumps the spark gap, the tube is too high. If it does not jump, decrease the spark gap until it does, and then find out the distance, which is spoken of as the number of inches the tube "backs up." The vacuum

of the tube should always become more perfect; that is, it should increase a little while the tube is at rest. If it falls below normal it should be sent to the manufacturer for repair. If gas tubes are used carefully, with the same amount of current every time and the same vacuum, they generally stop fairly even, and only slight adjustment is necessary before use. If the operator has occasion to take pictures of parts varying in radiability so that he has to use rays of varying penetrating power, it is well for him to keep a special tube for each type of work, rather than to change continually the vacuum of one tube.

Another method of testing the vacuum of the tube is by means of a volt meter, which is attached to most interrupterless transformers. The determination of the voltage by a volt meter, however, is not always reliable and it is safer to use the spark gap to judge the tension of the current.

The third way is by means of the milliampère meter. After the proper milliampèrage has once been determined we know that, with the same working strength of the machine (the same notch on the rheostat), the tube is too high if the reading on the milliampère meter is below normal, and too low if the reading is above normal. If the milliampère meter is a delicate one, or has two shunts, the testing can be done with the rheostat at the lowest notch. After the correct reading, with the rheostat on the first notch and the condition of the tube as desired, is once determined it is used as a factor in regulating the tube, and before taking a picture the tube is adjusted according to the factor. If the Roentgen machine is equipped with three terminals the vacuum in the tube can be corrected without moving from the switchboard of the machine, the third terminal being connected with the vacuum chamber. If there are only two terminals, the wire leading to the cathode will have to be changed to the terminal on the regulating chamber for lowering the vacuum and back to the cathode for testing, alternating in this manner until the test proves the vacuum correct. Only a very weak current should be passed through the regulating chamber and utmost care should be taken not to lower the tube too much.

The following gives in tabular form the different qualities of a high and low tube.

High tube.	Low tube.
Vacuum high.	Vacuum low (less perfect).
Color, light green.	Color, bluish green.
Resistance great (long spark gap).	Resistance slight (short spark gap).
Voltage high.	Voltage low.
Milliampèrage low.	Milliampèrage high.
Produces hard rays.	Produces soft rays.
Rays of high penetrating quality.	Rays of low penetrating quality.
Pictures show less contrast.	Pictures show great contrast.

Time of Exposure.—A large number of factors determine the time of exposure.

1. *The quality, that is, the penetrating power of the Roentgen rays generated by the tube.* This, as already seen, is governed by the voltage, or spark gap, of the tube.

2. *The quantity of the Roentgen rays produced,* determined by the milliampèrage of the current passed through the tube. The amount of milliampèrage at the operator's disposal depends upon the power of the Roentgen machine. Large transformers always have considerable reserve strength.

3. *The distance of the target from the plate.* The greater the distance the better the picture, but the time of exposure lengthens in proportion to the square of the increase in the distance. If, for example, the distance is doubled, the exposure should be four times as long, all other conditions being the same.

4. *Variations in the radiability of the object.* Not only is there a difference in the radiability of the various parts of the body, but also the same parts vary in different patients. The thickness of the bone and the degree of calcification are most important factors. Tissues offering great resistance to the Roentgen ray require, besides a different penetrating quality, longer exposure.

5. *Sensitiveness of the Roentgen plate or film.* Another factor is the difference in the rapidity of films or plates. The time can also be greatly reduced by the use of intensifying screens.

There are small machines with which Roentgen pictures can be

Object	Target distance in inches	Resistance of tube back-up in inches	Make of film	Milliampères	Time of exposure	Milliampère seconds	Milliampère seconds for changed target distance, D_b
Letters used in equation	D_a	V		A	T	$A \times T$	$\frac{A \times T}{\left(\frac{D_a}{D_b}\right)^2}$
Teeth intraoral	15	4	Eastman or Buck	30	5	150	$\frac{150}{\left(\frac{15}{D_b}\right)^2}$
Jaws intraoral	18	4		35	6	210	$\frac{210}{\left(\frac{18}{D_b}\right)^2}$
Jaws extraoral	20	4	Eastman, Double-coated: With screen	35	2	85	$\frac{85}{\left(\frac{20}{D_b}\right)^2}$
			Without screen	35	7	260	$\frac{260}{\left(\frac{20}{D_b}\right)^2}$
Sinuses, anterior-posterior view . . .	22	4½	With screen	40	2-3	80-120	$\frac{80\text{-}120}{\left(\frac{22}{D_b}\right)^2}$
			Without screen	40	8	320	$\frac{320}{\left(\frac{22}{D_b}\right)^2}$
Sinuses, lateral view . . .	24	3½	With screen	30	2	60	$\frac{60}{\left(\frac{24}{D_b}\right)^2}$
			Without screen	30	6	180	$\frac{180}{\left(\frac{24}{D_b}\right)^2}$

For Coolidge tubes use about four-fifths of the above milliampère seconds.

Increase the milliampère seconds for individuals with heavy bone; decrease for individuals with light bone.

If any of the above factors need to be changed it may be done according to the following equation:

$$\frac{V^2 \times A \times T}{D^2} = \text{Constant}$$

taken with a very short exposure. This is principally due to the use of small tubes with a short or no cone, allowing a shorter distance between the target and the plate.

The large transformers have sufficient power to take pictures in the same short time with the longer target distance. For dental films, however, a longer exposure with less milliampèrage is preferable. The table on page 39 gives full information for Roentgen pictures of the teeth and face.

Roentgen Negatives, Screens, Prints, Lantern Slides and Reproduction by the Printing Process.—The Roentgen negative is the picture produced on either a sensitive film or plate. For intraoral work films are used entirely. Various sizes are manufactured by the Eastman Company, the three sizes of dental films being 1¼ x 1⅝ (No. 1), 1½ x 2¼ (No. 1*a*) and 2¼ x 3 inches (No. 2). These were wrapped first in black paper and then enclosed in an outer wrapping of red oiled paper. The edges have to be carefully rounded before using, so that they will not hurt the patient's mouth. The Buck X-Ograph Company, of St. Louis, Missouri, manufactures a new type of film called the X-Ograph packet, which has several advantages. It is extremely thin, with smooth margins and corners; it has a special metal backing, which increases the detail and contrast in the picture; it can be bent to conform to the curves of the mouth and remains in that position, which makes it more easily placed and retained during the exposure. On account of this and its thinness it has less tendency to cause nausea in a patient with a sensitive throat. These films are made in only one size, 1¼ x 1⅝ inches. The Eastman Kodak Company is also making a new film which, except for a thicker margin, has the same advantages. Just as the manuscript was about to go to press the Eastman Company sent the writer samples of a still more recent film, which has a translucent base. These films are coated on a special, light-diffusing base, so that each film may be viewed at any time, even unmounted, with the ease formerly possible only when held before opal glass or a similar diffusing medium.

Dental Roentgen films are frequently made "extra-fast," requiring only about one-fifth the exposure needed for the regular film. The latter, however, generally give better results.

For extraoral methods, plates of various sizes, 6 x 8, 8 x 10, etc., have been employed. At present these are about to be replaced entirely by film. The new Eastman Dupli-tized films are far superior to any plates; they are also much more convenient to mail and take up less room in the files.

Intensifying Screens.—Intensifying screens may be used, preferably in a screen holder or cassette, which brings the film into close contact with the screens (Figure 16). These screens are made of cardboard, coated with a smooth layer of clear white chemical compound, having a base of calcium tungstate. One may use single or

FIGURE 16.
Plate Holder for Dupli-tized X-ray Films with Screens.

double screens, the latter with double-coated films. The screens make it possible to reduce the time of exposure without impairing the quality of the result; on the contrary better negatives, with sharper detail and better contrast are obtained. Only a very small percentage of the Roentgen rays striking a photographic plate or film produce the image, under ordinary circumstances. With the use of the screen a large number of otherwise wasted rays cause a fluorescence; the rays are absorbed, changed and emitted as actinic light, which will act upon the emulsion. In this manner the exposure can be decreased to at least one-fourth of the normal time.

Photographic Prints.—Photographic prints are often made from the Roentgen negative. These, in the writer's opinion, are of little value, as the picture is reversed (Figure 17*a*). All roentgenologists use the negative Roentgen picture for making their diagnoses, and the prints tend to confuse those who are not even very familiar with the reading of ordinary Roentgen negatives. If duplicates are wanted, one to keep on record and one to send with the Roentgen diagnosis, two films or plates may be used, one placed over the other, and exposed simultaneously. The manufacturers of the intraoral dental films always put two films in each package.

FIGURE 17*a*.
Reproduction of a Roentgen picture in the positive.

FIGURE 17*b*.
Reproduction of a Roentgen picture in the negative.

Lantern Slides.—A quick way of making lantern slides from small films is by placing them between two glass slides, with a black paper mat, in which a hole is cut the shape of the film, but somewhat smaller. To make regular lantern slides, a transparency should be made first. This is done by the contact method if the picture is of the desired size. The method is the same as that of making a print, but instead of paper, another plate or film is used. Should it be necessary to reduce or enlarge the Roentgen picture, a special apparatus is required for the purpose. The lantern slide, being made from the transparency, gives a negative picture of the same appearance as the original.

Reproduction for Publication.—For reproducing roentgenograms, photographic prints have been generally used in the past. Besides the disadvantages already mentioned, there are other objections to

the use of photographic prints of the negative (positive pictures), for lantern slides as well as illustrations. They are practically worthless if used for teaching, or for illustrations in text-books, because they fall short of their purpose. The principal aim of illustrations in a published article, or text-book on roentgenology, should be to familiarize the student with the Roentgen appearance of the various tissues in health and disease. This can only be accomplished by using reproductions of roentgenograms such as are seen in daily practice (Figures 17*a* and 17*b*).

Method of Exposure for Small Intraoral Dental Films.—Roentgen pictures of the teeth are usually made on the smallest dental films. The patient is seated in the dental chair, the head rest adjusted so that the head is in normal position, the occlusal surfaces of the teeth being in a horizontal plane. It is easier to calculate the correct angle when the patient is in this position than when the head is thrown back. The film is placed in the mouth by the operator and the patient is directed to hold it with his index finger. The right hand is used for the left side and the left hand for the right side. An ordinary cork may be used to hold the film. The cork should be slightly flattened on two opposite sides. A groove should be cut lengthwise, into which the edge of the film is inserted. The cork is then placed in the patient's mouth and he is directed to bite on it. Other film holders are in the market and, no doubt, have their advantages. The close adaptation to the tissue which the small films permit is the principal reason why they show better detail than extraoral plates, both of normal and diseased conditions. Extraoral pictures, of course, are excellent when a survey of the entire jaw is wanted. The milliampèrage, or the time of exposure, should be slightly changed for patients with abnormally heavy or thin bone, also according to the region of the mouth which is being roentgenographed. In the mandible the bone is much more massive in the molar region than in front and in the maxilla it should be remembered that it is often necessary to penetrate the zygomatic process to take a picture of the first or second molar. Three or four teeth can be taken on one film and if all the teeth are to be roentgenographed it will usually be necessary to take a series of ten films.

The angle at which the rays are directed is of greatest importance. No hard and fast rule can be set. It is a question of individual judgment and geometric calculation. The flat or the V-shaped vaults require an entirely different angle for pictures of the upper teeth from the high square vault with long alveolar process. Often it is necessary to take pictures from two angles and from different lateral aspects to get exact information regarding two- or three-rooted teeth.

If the object could always be placed close to the film and so as to have the planes through the film and through the object parallel, the correct angle could be easily determined. The rays, if applied in a vertical direction would give a picture practically duplicating

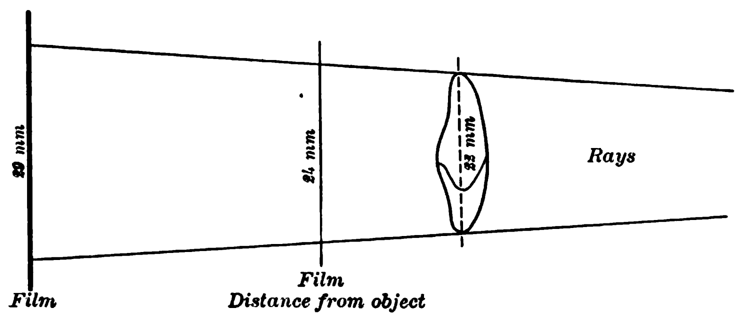


FIGURE 18.

the object, except perhaps for a very slight enlargement, due to the fact that the Roentgen rays are more or less divergent. This enlargement becomes greater if the distance between the object and the target is decreased and also if the distance between the object and the film is increased (Figure 18). This condition is possible for the mandibular molars only. In most other parts of the mouth the film has to be placed at an angle, on account of the formation of the investing tissues of the mouth.

Just as soon as the plane of the object is at an angle to the plane of the film the question arises as to whether the rays should be directed perpendicular to the former or the latter, or whether they should be perpendicular to a plane between the two. In Figure 19 the rays

were perpendicular to the object, the result being an elongation of the picture. The tooth, the actual length of which is 22 mm., measures in the picture 24 mm.

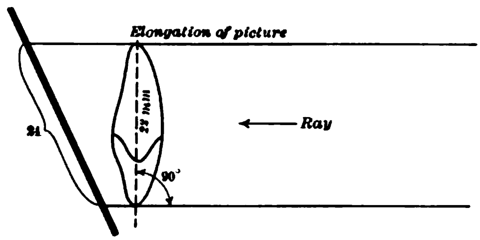


FIGURE 19.

If the rays are directed vertical to the film, the result is a foreshortening of the picture of the tooth (Figure 20).

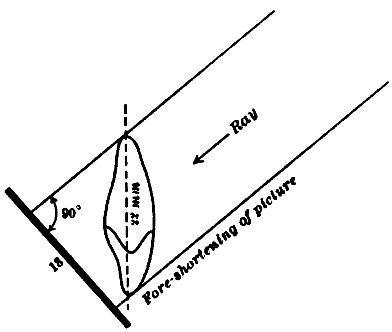


FIGURE 20.

The right direction is exactly half-way between the two, as shown in Figure 21. The same result may be obtained by directing the rays perpendicular to an imaginary plane lying exactly half-way between the plane of the tooth and the plane of the film (Figure 21).

Elongation of the teeth in the picture may be due to an incorrect angle as just described, but we may get a similar result if the film is bent very much. This is sometimes the cause of the most extreme elongation of the root end. If anatomical conditions do not allow proper placing of the film, the elongation can be overcome by over-

correction; that is, by choosing an angle which, under normal conditions, would foreshorten the picture of the tooth (Figure 22).

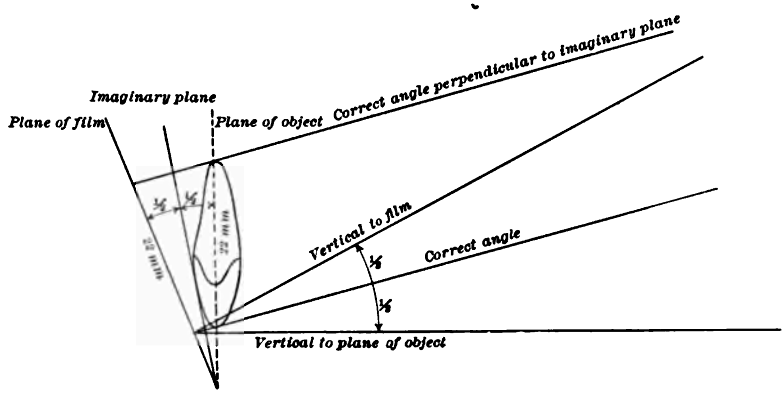


FIGURE 21.

The maxillary incisors can usually all be taken on one film, except in mouths with very narrow, V-shaped arches, compressed from side to side. In such cases the left and right sides should be taken separately. Figure 21 shows the correct angle for direction of the rays.

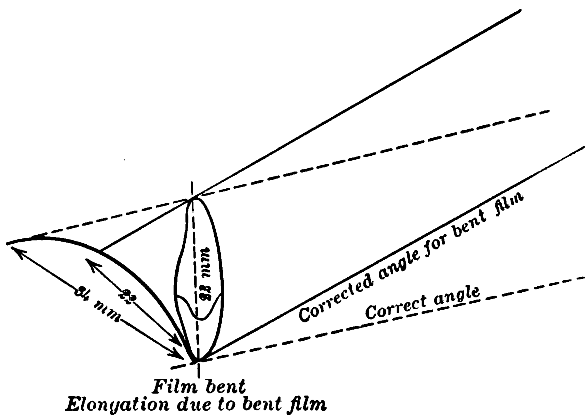


FIGURE 22.

The maxillary cuspids and bicuspids and, in children, the deciduous molars, can be taken with one exposure. The angle is calculated

exactly the same way as for the incisors. Variations, however, are sometimes necessary in the lateral position of the tube. The tube may be placed exactly opposite the teeth, or the picture may be taken from a distal or mesial point of view. The first position gives a strictly

FIGURE 23.

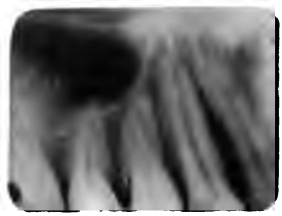


FIGURE 24.

buccal view of the first bicuspid, in which the two roots, if present, are usually overlapping and, therefore, not distinguishable (Figure 23). The distal position gives a bucco-distal view of both bicuspids, the buccal root of the first bicuspid being projected nearer the cuspid; the lingual one nearer the second bicuspid. This position, however, often results in distortion of the cuspid root, on account of the curve

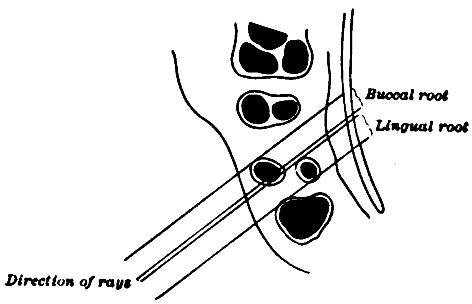


FIGURE 25.

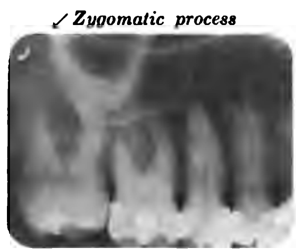


FIGURE 26.

of the maxilla. The mesial position (Figure 24) is used by the writer for routine work. In this position the mesio-buccal side is pictured, showing both roots of the first bicuspid, this time the buccal one being nearer the second bicuspid and the lingual one nearer the cuspid (Fig-

ure 25). If the position chosen is too far from the mesial side, overlapping of the roots is likely to appear in the picture.

The maxillary molars, especially the first and second molars are the most difficult of all the teeth to roentgenograph. The zygomatic

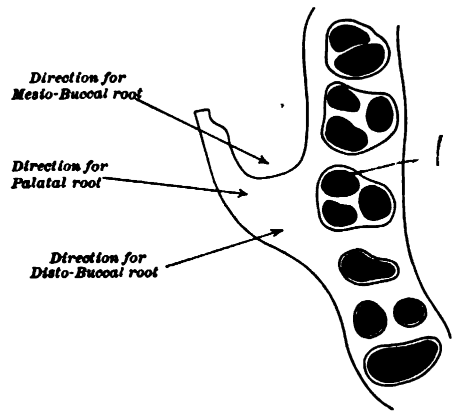


FIGURE 27.

process, which has its origin directly opposite the roots of the first molar, is interposed and often obscures the picture. Its penetration requires an increase in milliampère seconds (Figure 26). A distal or mesial direction usually overcomes this anatomical difficulty (Figure

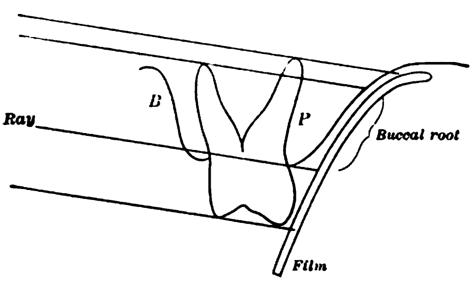


FIGURE 28.

27). Quite frequently the roots of molars become superimposed and are not easily distinguishable. This difficulty is overcome by using a low position of the tube (Figure 28), which has a tendency to distort the palatal root and give normal pictures of the buccal roots. With

the distal exposure (Figure 29*a*) we usually project the mesial root separately on the film, and with the mesial exposure, we generally get a clear and distinct picture of the distal root (Figure 29*b*). In teeth

FIGURE 29*a*.

FIGURE 29*b*.

with very divergent roots it is also possible to get an almost normal picture of the entire palatal root, with the buccal roots foreshortened by directing the rays from a high position of the tube (Figure 30).

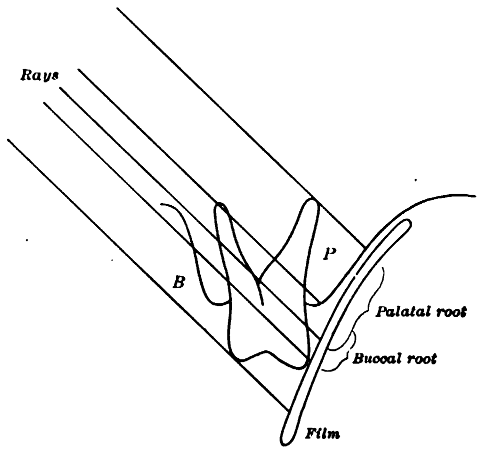


FIGURE 30*a*.

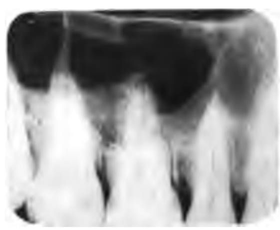


FIGURE 30*b*.

The correct angle may be found in the manner described above (Figure 21), the tooth being regarded as made up of two parts, a buccal and a palatal one. Each part, when roentgenographed, is considered as a single rooted tooth. From this it is evident that it is sometimes necessary to take two or three exposures from different angles for a complete investigation of the maxillary molars.

4

The mandibular incisors are roentgenographed in the same manner as the maxillary incisors. The four incisors can generally be taken on one film. However, a different position of the tube is necessary to get the right angle. The chin should be held as high as possible, so as to give plenty of room for the tube in front of the patient (Figure 31). In some cases a greater target distance may be necessary, and

FIGURE 31.
Position of Tube for Mandibular Incisors.

great care should be taken before making the exposure that there is no possibility of a spark jumping to the patient.

The mandibular cuspids and bicuspids, as in the upper jaw, are taken on one film. The film is usually parallel with the plane through the teeth, with the exception of the anterior corner, which often has to be rounded to prevent painful pressure. The direction of the rays,

therefore, is perpendicular to the film. For root canal work it is advisable to take the picture from a slightly mesial aspect, so as to make sure of the number of root canals. There are frequently two canals found in mandibular bicuspids and occasionally also in the cuspids.

The mandibular molars require approximately the same angle as the bicuspids, except when they are inclined to either the buccal or lingual side. A mesial or distal aspect is preferable, so as to bring out both root canals in the mesial roots of the molars. The bone may be very thick in this part of the mandible and it is, therefore, advisable to increase the milliampère seconds.

Method of Exposure for Large Intraoral Film.—The two larger sizes, the No. 1*a* and No. 2 dental films, are used in the intraoral method to cover a larger part of the bone investing the teeth. They are especially useful for unerupted and misplaced teeth, large cysts in the anterior part of the maxilla and mandible and also to locate foreign bodies and calculi in the ducts and glands of the floor of the mouth. The No. 1*a* film is used the same as the small dental film.

The No. 2 dental film is not put in close contact with the tissues, but simply placed between the teeth, as far back as possible. The patient is directed to bite on it lightly. The emulsion side of the film should face the part to be roentgenographed. The direction of the rays for pictures of the maxilla should be almost perpendicular to the film (Figure 32). For the mandible it is necessary to adjust the head-rest of the dental chair so that the patient's head can be tipped back sufficiently to allow the tube to be placed in a position from which the rays can be directed almost perpendicular to the film (Figure 33).

Method of Exposure for Extraoral Pictures of the Jaws.—The large extraoral plates are very useful for making an entire survey of the region involved. Without them, malposed teeth, large cysts, affections of the ramus and body of the mandible and diseases of the sinuses might often escape notice, as such conditions cannot be included in the small dental film used inside the mouth. The roentgenogram is made on a $6\frac{1}{2}$ x $8\frac{1}{2}$ or an 8 x 10 inch plate or film. The writer has

lately been using entirely Eastman's double-coated films in a cassette with intensifying screen. The exposure can be made with the patient in a sitting position in the dental chair. The plate, or cassette, is placed against the cheek with the back part against the head-rest

FIGURE 32.
Position of Tube for Anterior Part of Maxilla with Large Film Placed between the Teeth.

of the chair and the bottom resting on the patient's shoulder. It is further supported by the patient's hand, as seen in Figure 34. The head should be bent toward the plate with the chin projected forward and upward. The rays are directed at an angle of about 45 degrees,

FIGURE 33.
Position of Tube for Floor of Mouth with Large Film Placed between the Teeth.

so as to prevent superimposition of the ramus or body of the opposite side of the mandible. Experiments with a skull for the subject will give the beginner the best idea of how the tube should be placed. The angle can be varied from an inferior to a posterior direction. With the former, when the rays come more from below, we get excellent

FIGURE 34.
Position of Tube for Extraoral Roentgen Picture of the Maxillary Bones on One Side.

FIGURE 35.
Roentgen Picture Taken from an Inferior Position to Show Entire Ramus.

pictures of the ramus and the posterior teeth, both in the maxilla and mandible (Figure 35), while a picture taken from a higher position, but more from behind the ramus of the opposite jaw, will show the condition of bone in the region of the anterior teeth, especially if the anterior part of the face rests more closely on the plate. The picture of the cervical vertebræ comes usually over the ramus and obscures

FIGURE 36.

Roentgen Picture Taken from a More Posterior Position. In this picture the spinal column obscures the ramus, but the anterior part of the mandible, as well as the maxilla, is made visible.

the postmolar region. The teeth are all taken from a distal view and are generally not as well defined as in the first method (Figure 36).

Another method of taking extraoral roentgen pictures of the jaws is by having the patient bend forward and place the head on a table which is in front of the chair. A head holder may also be used, as in sinus work. The angle is chosen just as described above. (For time of exposure see table on page 39.)

Method of Exposure for the Sinuses of the Face.—To diagnose conditions of the sinuses it is necessary to take a frontal picture of the face, because we must have a picture of both sides in order to compare the sinuses on one side with those on the other. Intraoral films will give no information, although part of a maxillary sinus can frequently be seen in roentgenograms of the posterior teeth in the maxilla. Eyeglasses, artificial upper dentures and hairpins of all descriptions should be removed before the picture is taken. A table with head holder or sinus block (Figure 37) should then be placed in front of the chair. The tube stand is so adjusted that the rays are perpendicular to the film in a lateral plane. If all the sinuses are to be taken the patient's head should rest on the plate so that the forehead and

FIGURE 37.
Head Holder Used for Sinus Pictures.

nose touch it, the nose pressing down as much as possible. The rays are then directed from an angle of about 25 degrees, the central ray coming about to the bridge of the nose when viewed from the side (Figure 38). This exposure gives an anterior-posterior view of the frontal and maxillary sinuses and the ethmoidal cells. It is important that the tube be adjusted with great care. A slightly lateral direction interferes with the possibility of comparing the conditions on the two sides, while a faulty angle in the other direction may result in superimposition of some of the prominent ridges over the sinuses.

The best pictures of the maxillary sinuses can be obtained by using Water's position. This, however, does not always include a good view of the frontal sinuses and seldom brings out the ethmoidal

cells. The patient's head is placed with the chin and nose touching the plate, then the rays are directed vertically downward, the central ray going through the upper lip (Figure 39).

Side views of the head are often used to locate a cyst, or a tooth or foreign body which is supposedly in the maxillary sinus. The side to be examined should be placed toward the plate. A sagittal

FIGURE 38.
Position of Tube, with Different Type of Head Rest, for Anterior-posterior View of Accessory Nasal Sinuses.

plane through the head should be parallel to the plate, and the direction of the rays exactly perpendicular, the tube centered to the external canthus of the eye. This position is also used for the sphenoidal sinuses.

The best sinus plates are made with the double-coated film and a double screen, which decreases the time of exposure and obviates the necessity of the patient being still for as long a time as the old method

required. Patients should always be questioned as to whether they have had roentgenograms of the sinuses made by anyone else within ten days or a week. Not more than two or three anterior-posterior pictures should be taken of any one patient within a week, on account of the danger to the growth of the hair. For the same reason it is also important to have the tube properly adjusted. There is greater

FIGURE 39.
Position of Tube for Taking Pictures of the Maxillary Sinuses, Water's Position.

danger from a tube which is too low than from one which is too high. To avoid fogging of the plate a long cone of 3½-inches diameter at the outlet should be used with a small diaphragm to eliminate as much as possible all secondary radiation caused by the brain.

Stereo-roentgenograms.—Stereo-roentgenograms are very useful for certain conditions, especially to get an idea of the exact dimensions

(in all directions), of a foreign body or tooth inside the jaws or face. It will reveal whether the tooth is impacted or free, whether the root is curved or not and in which direction, and it will show whether it is located labially or lingually to the other teeth. In a word, it will give information in three dimensions, while the ordinary Roentgen picture is limited to the two of a plane. It is impossible, for example, to tell from one Roentgen picture of an unerupted cuspid whether it is located on the labial or lingual side of the roots of the other teeth.

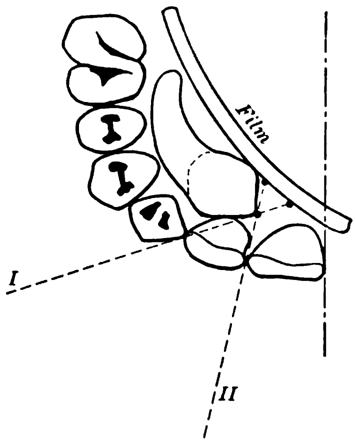


FIGURE 40.

Diagram Showing How to Determine Geometrically Whether an Unerupted Tooth Lies Lingually or Buccally. *I*, first angle of exposure—distal surface of lateral incisor and cusp of cuspid lie in the same plane; *II*, second angle of exposure—distal surface of central incisor and cusp of cuspid lie in the same plane.

If only such simple information is desired it can easily be gained by means of two exposures from different points of view, as illustrated in Figure 40. An exposure from a buccal aspect would cause the tip of the cuspid to appear to be covered by the root of the temporary cuspid, while in a second picture with the tube more toward the labial side, the cusp of the unerupted tooth would come in line with the distal surface of the central incisor. Other problems can be figured out very easily in a similar manner by means of a drawing. Raper, who has written several articles on this matter, formulated the following rule:

"To localize unerupted teeth, make two or more roentgenograms, shifting the tube laterally. If the location of the unerupted tooth in the picture changes toward the direction in which the tube is shifted, the tooth lies lingually. If the location of the tooth in the picture changes in the direction opposite to that in which the tube is shifted, it lies facially."

Technic of Making Stereo-roentgenograms.—The principle involved is simple. Two ordinary roentgenograms are taken from points two and a half inches apart. The distance corresponds to the distance between the pupils of the eyes. The tube must be adjusted so that the central ray strikes the center of the film. There are special tube-holders made for this kind of work, which will facilitate the moving of the tube for the second exposure. It should be remembered that the tube, besides being moved two and a half inches laterally should also be tipped so as to bring the central ray again to the center of the second film. To get successful pictures it is absolutely necessary to prevent the patient from moving while the two exposures are being made. This can usually be done by bandaging the head to the chair. Furthermore it is necessary to place the film each time in the same plane in the mouth. It is not so important to have them in exactly the same place. For the upper jaw, therefore, it can be placed between the teeth, with the patient biting on it. To do this, one should use a large film, which can be cut down later if desired. For the mandible Kells has described how to make a simple guide plane for placing the film. "A piece of aluminum plate, No. 30, B. & S., is cut to the pattern shown in Figure 41, A. The slotted edge is then turned over to about a right angle and the lugs at each end bent over, as shown in Figure 41, B. The slotted edge is then slightly warmed over a Bunsen flame and a piece of soft modeling compound is attached to it. This is placed in the mouth, plane surface pressed against the inner surface of the jaw and held there while the compound is molded over the crowns of the teeth. The patient then closes down carefully upon it—mouth opened—the plane again adjusted in place in case it has moved away during the occlusion. It is then cooled by means of a jet of cold compressed air, or a spray, and then removed (Figure 41, C).

The films are clamped in place by little lugs at each end. The film-holder is now placed in position in the mouth, the teeth closed gently against it so as to be assured that it goes to place, and the exposure

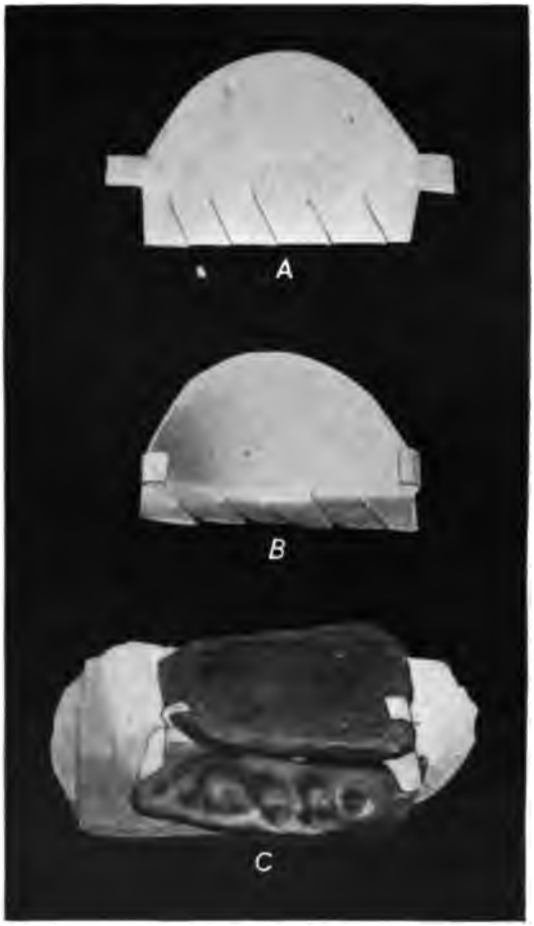


FIGURE 41.
Kells's Guide Plane for the Taking of Stereo-roentgenograms.

made. The plane is then removed, film taken off, another one put on, the holder returned to the mouth, where it must be replaced to its exact former position, which is readily done, and the second film

is thus held on the same plane as was the first, and the exposure made. With the patient placed in a comparatively comfortable position, so that he may be able to sit immovably during the process, and care being used to carry out these details without the loss of any unnecessary time, perfectly satisfactory stereo-roentgenograms can be obtained of teeth of the mandible."

Other film-holders are manufactured by the various supply houses.

When the exposure is made, the same penetration, milliampèrage and time should be used for each film and the development should be carried to absolutely the same degree for both. This is easily accomplished by placing them in the developer and removing them at the same time. After the films are finished, a set is placed upon a sheet of glass, two and a half inches apart, center to center, and attached by means of gummed paper strips. A piece of dark pasteboard the same size as the glass, which should fit the stereoscope, should be prepared with two holes cut to correspond with the size and position of the films. Kells advises marking one of the packages of films by placing upon the side facing the tube a small metallic letter L, which marks this film as the left film and helps in mounting them properly. He also advises placing fine wires around two of the teeth on opposite ends of the region to be roentgenographed. This facilitates the registering when viewing them in the stereoscope. In regard to the aspect from which the part is viewed, Kells, to whom we are indebted for a large amount of the progress in this work, writes: "If the left eye picture is placed on the left and right picture on the right of the stereoscopic box, upon looking at them it will be found that we are looking through the jaw from the same direction that the rays were thrown. In this case, for instance, with the picture so placed, we appear to look down through the buccal plate, through the alveolar process and so on. Everything appears in just these relative positions. As a matter of fact these pictures present a buccal aspect of the case. But let us reverse the pictures, placing the left eye picture on the right and the right eye picture on the left and a most wonderful transformation has taken place, for now we are looking through the jaw from a position within the mouth and now they present an actual lingual

aspect. Strangest of all is the fact that viewing pictures in this direction is the more satisfactory of the two, so that the pictures are always reversed for reading."

IV. DEVELOPMENT OF ROENTGEN FILMS.

The films are developed in a dark room, by the light of a dark-room lamp (Figure 42), or in a developing cabinet (Figure 43). Three porcelain bowls, approximately five inches wide, are used to contain the developer, the fixing-bath and the rinsing water. Special clips (Figure 44) are designed to use with such bowls. They facilitate the management of the films and make it possible to do the developing

FIGURE 42.
Dark Room Light.

without immersing the fingers in staining chemicals. A clip is attached to each film, and care should be taken to wash the clips well after use. The developing fluid is best prepared from powders, which are manufactured by concerns such as the Eastman Company. After using, it should be poured back into a bottle, or covered, to prevent free access of air, which causes oxidation. It is a good principle to add a certain amount of new developer when it is re-used, as the chemicals become less active with age and use. The fixing-fluid can be used for a considerable length of time and may safely be kept in an open bowl. The films must be well rinsed after they are taken from the developer, before being transferred to the fixing-bath. The temperature of the

developing fluid affects the picture considerably, and in winter it is often necessary to heat it slightly. The proper temperature is about 65° F. In hot weather the films are often spoiled because the emulsion

FIGURE 43.
Developing Cabinet for Dental Films.

FIGURE 44.
Clip to Hold Film for Developing and Drying.

becomes too warm and melts, or causes blisters to appear on the surface of the film, or frills on the margin. It is sometimes advisable to use iced water for the washing and to cool the solutions. The writer prefers to add a teaspoonful of alum to the fixative, as well as to the rinsing water. The astringent action preserves the emulsion.

Roentgen films are developed in the same manner as photographic negatives, and he who has some experience in photography will be able to save a good many pictures which have not been quite properly exposed. The inexperienced operator will probably get more satis-

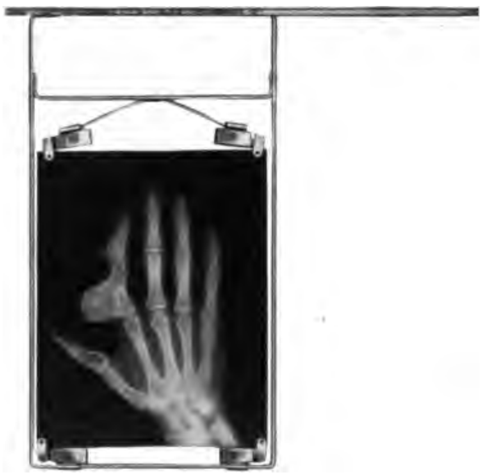


FIGURE 45.
Film Holder for Large Dupli-tized Roentgen Films for Tank Development.

factory results if he times the developing. With the Eastman developer for dental films the time is five minutes, after which the film is rinsed in clear water and placed in the fixing-bath until it is entirely transparent when held to the light. If the first film is overdeveloped, that is, if it is too dark, the other exposures should be shortened; if it is too light, from underdevelopment, the time of exposure should be lengthened. A film may be left in the fixing-bath any length of time without its being spoiled. After it is fixed, the film should be washed in running water for about fifteen minutes, or in standing water for an hour, during which time the water should be changed

several times. It should be finally hung up by the hook of the clip to dry, and when dry it is finished. The drying process may be hastened by putting the film into alcohol for a few seconds after washing it.

FIGURE 46.
Film Registering Holder.

Large dupli-tized films for extraoral exposures are more easily developed by the tank method. After exposing the film, it is placed in the holder, shown in Figure 45, in which it passes through developer, fixative and rinsing water. It is dried in the same holder and, after being removed, is perfectly flat.

There are various opinions as to the appearance of a perfect Roentgen negative. Some roentgenologists like them very dark, so as to necessitate holding the film in front of a strong light, while others

prefer pictures which are light but with good contrast, which may be examined in ordinary daylight, as, for example, in front of a window. The writer prefers the latter type, which are made with a fairly high penetration, but backed up by enough milliampère seconds to give, if properly developed, an entirely black picture of the radioparent parts, and a very translucent picture of the parts which are radiopaque.

A holder, Figure 46, for individual films has been constructed by the Buck X-Ograph Company, of St. Louis, for the purpose of examining pictures. Both films from the same packet can be placed in this holder and when viewed, the contrast and detail will be brought out as well as if a dupli-tized film had been used.

V. RECOGNITION OF THE CAUSES OF POOR RESULTS.

It is generally difficult for the student to determine the cause of a poor picture and to find the reason for his failure to get as good results as someone else. Frequently he blames the machine when the fault is clearly one of technic. When trying to trace the cause of a failure, it is best to think the matter over carefully and to consider first the machine. It can be easily and quickly tested by attaching it to a tube with a certain back-up and taking the reading of the milliampère meter. If the reading is less than usual it is a sign that the output of the machine has been decreased. This may be due to a drop in the incoming street current, or improper functioning of the interrupter or induction coil, or the transformer or commutator, or other parts, according to the type of machine.

The tube may not be working properly. Gas tubes often become freakish, flitter and become soft during the exposure. If the tube is too high the picture will not show enough contrast and will appear flat (Figure 47). If the vacuum of the tube is too low there is not enough penetration of the hard tissue and the resulting picture will appear thin (Figure 48). In Figure 49 the patient moved and the picture, therefore, is not very clear.

The result of overexposing and underexposing can often be corrected by proper development. Such errors are due to exposing the


FIGURE 47.


FIGURE 48.


FIGURE 49.


FIGURE 50.


FIGURE 51.


FIGURE 52.


FIGURE 53.


FIGURE 54.


FIGURE 55


FIGURE 56.


FIGURE 57.


FIGURE 58.

film too long, or for too short a time, or to the use of too large or too small a milliampèrage. If too many milliampère seconds are employed, and the picture is developed the normal length of time, it becomes very black, and may be so dense as to make it impossible to read it, even by a very strong artificial light (Figure 50). An overexposed picture develops almost instantly and can only be saved by immediately diluting the developer and removing the film as soon as it is finished. Overexposed pictures may also be improved by the use of a reducing fluid, such as can be bought from any photographic supply house. If too few milliampère seconds are used the picture develops very slowly, the radioparent parts fail to become black enough, and if the development is forced (that is, if it is continued much longer than usual), the negative becomes fogged and after being fixed, often has a yellowish color (Figure 52). Figure 51 shows the normal roentgenogram of this series.

The effects of development have already been described. When the developer is too cold, the result is a very thin picture, as shown in Figure 53. A similar condition may be produced by developer which is too old, or by underdevelopment of the negative (Figure 54). An overdeveloped picture looks about the same as an overexposed one (Figure 55).

Other poor results may be produced by movement of the patient, vibrating of the tube, or slipping of the film, which cause the picture to become indistinct and lose its sharpness. If the supply of films is not properly stored they may become fogged (Figure 56). Films should be kept in a lead box, so as to protect them from the rays when exposures are being made. Daylight will not affect them, so long as the packing is intact, but if the packing becomes torn, or if light is allowed to strike the film through carelessness before or during the development, the picture may be partly defective, fogged, or entirely spoiled (Figure 57). Hot weather often causes the emulsion on the film to melt, as seen in Figure 58. A method to prevent this has been described above.

PART II.

INTERPRETATION OF ROENTGENOGRAMS.

TO interpret a Roentgen picture correctly is the most important work of the roentgenologist. It is absolutely necessary that he should have careful training and special knowledge in the anatomy, histology and pathology of the parts he is to examine. If he is a dental roentgenologist he should also be familiar with the various dental procedures and problems of dentistry, or he will not be able to coöperate with the general practitioner sufficiently to give him the greatest possible benefit from his services. The writer cannot forego this opportunity to lament the fact that, on account of inefficient laws, Roentgen laboratories have been established in most of the larger cities by laymen, who not only make Roentgen pictures, but also supply most elaborate reports. Through advertising they attract patients and, worse still, dentists refer their own patients to them. Such practitioners lower the standard of this important specialty and of the dental profession in general, to say nothing of exposing their patients to false advice, based upon the opinion of an ignorant person.

The value of Roentgen diagnosis depends upon correct interpretation of the picture and such interpretation can only be made from a good roentgenogram. When reading a picture, however, one should not forget the history of the case and the clinical findings. The roentgenogram does not picture disease. It only records tissue radiability changes, which may have been brought about by pathological processes, or surgical and medicinal treatment. Such changes in the outlines, or radiability, are correct and accurate pictures of the grosser structural abnormalities; finer pathological conditions, such as those seen under the microscope, cannot be recognized. A Roentgen diag-

nosis, therefore, is made by drawing deductions from the records made by the Roentgen examination, and the roentgenologist must become proficient in associating Roentgen signs with corresponding diseased conditions. In a roentgenogram of a tooth, for example, the picture of the pulp is the same whether diseased or normal, but if a dark area, indicating decay, is shown in the crown of the tooth and if this area comes close to the pulp, one may suspect pulp disease. If there are symptoms, or clinical evidence of pulp disease, the diagnosis is fairly certain. If, in addition to the above, the picture shows changes associated with infection around the apex of the tooth the roentgenologist can, from this evidence alone, without clinical indications, draw conclusions which lead to the diagnosis of pulp disease.

With advances in technic and improvement in the quality of the pictures it is possible to demonstrate finer changes, while experience, careful observation and systematic study of a large number of similar cases, as well as comparison of Roentgen diagnoses with operative findings, or results of pathological examinations, will make it possible to carry the Roentgen diagnosis to a finer and finer point. As an example, take the differentiation between granulating ostitis and a radicular cyst. In both cases a large dark area may be shown in the film, due to the increased radiability of the area where loss of bone has occurred. Granulating ostitis is distinguished from the cyst by the appearance of the outline of the diseased part in the picture. An irregular margin and gradual change from the diseased to the healthy part indicates ostitis, while a clear demarcation of definite outline indicates that the bone itself has not become infected, but that pressure absorption has occurred, the bone cavity having been reinforced by a dense layer of normal cortical bone. This is the picture of a cyst.

A Roentgen picture is a record upon a photographic plate or film of the radiability of tissues through which the rays are passed. Soft tissue is very radiolucent and, if not too thick, transmits the rays used for bone work almost as well as air. Bone containing a large percentage of calcium salts is very much less radiolucent, and enamel, containing almost no organic matter, is the most opaque tissue in the body. Gold, silver, lead and other metals are also entirely

FIGURE 59.

FIGURE 60.

FIGURE 61.

Figure 59 shows normal teeth. Note the appearance of the crown of the second molar.

Figure 60 shows an oblong dark area in the picture of the crown of the second molar. This is due to a cavity drilled into the buccal surface, which increases the radiability.

Figure 61 shows a white area due to a silver filling placed into the cavity, decreasing the radiability.

opaque. Figures 59 to 61 illustrate changes in radiability. Figure 59 shows the normal molars in the mandible. A cavity drilled into the buccal surface of the second molar, increases the radiability and, since the obstruction to the passage of the rays is decreased, a dark shadow corresponding to the size and outline of the hole, appears on the film (Figure 60). Metal placed into this cavity renders the area impervious to the Roentgen rays and a light area is shown in the picture (Figure 61).

When examining a roentgenogram, look first for any departure from the normal, such as irregularity in size or outline of the object, or any change in its normal radiability. It is of great advantage to compare the part under observation with the corresponding part on the other side of the individual, especially when there is any doubt, when the appearance of the condition in the picture is not pronounced and not readily recognizable. The age of the patient should also be considered. An unerupted tooth, for example, is a normal condition in a child, while in an adult it deserves serious consideration.

Misinterpretation.—Misconceptions may arise from distortion of the angle at which the picture is taken, from faulty technic in the development, lack of sufficient knowledge to recognize pictures of anatomical structures such as the mental foramen, the incisive foramen and the maxillary sinuses, or shadows of interposing parts, such as the coronoid process of the ramus in the upper third molar region (Figure 71) or the nares, which are projected over the roots of the central incisor (Figure 143). The picture of the mental foramen may be projected so that it comes exactly over the apex of a bicuspid root, appearing the same as would an apical abscess. The mandibular canal, however, may usually be traced to it, which helps in the identification (Figure 99). The incisive foramen in the maxilla will often give a picture superimposed over that of the apex of the central incisor, especially if the exposure is made from a slightly lateral angle (Figures 62 and 64). A new film, taken from a different viewpoint will usually clear up all doubt (Figures 63 and 65). Beginners often mistake parts of the maxillary sinuses for extensive diseased conditions.

Figure 66 shows posterior teeth protruding into the maxillary sinus. The same condition is shown in the Roentgen picture (Figure

68). There is but a thin film of bone over the apices of the teeth, separating them from the dark area which is the sinus. In Figure 67, the roots do not protrude into the maxillary sinus. An abscess cavity

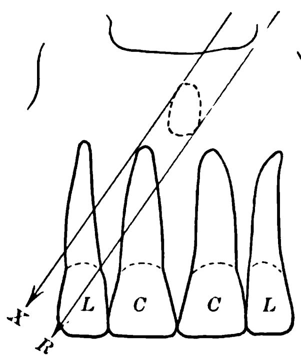


FIGURE 62.

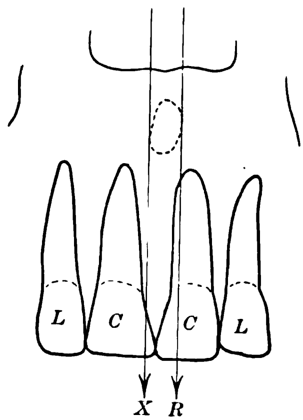


FIGURE 63.

Figure 62 shows an exposure from a lateral angle, such as often results in projecting the incisive foramen over the apex of the central incisor, as in Figure 64. If the rays are directed perpendicularly as in Figure 63, the picture of the foramen comes between the roots of the two teeth.

is seen on the palatal root of the molar. In a Roentgen picture such as Figure 69, part of the palatal root, as well as the area indicating the abscess cavity would appear to lie inside the sinus, but this is due to the angle at which the picture is taken.

FIGURE 64.

FIGURE 65.

In extraoral films the soft tissues sometimes become a factor to be considered. The tongue and muscles in the hyoid and mandibular regions decrease the radiability, while the pharynx, a space which is

radioparent, by contrast shows as a dark area in the picture. This area is often projected over the ramus or posterior part of the body of the mandible and may be mistaken for a fracture or a space pro-

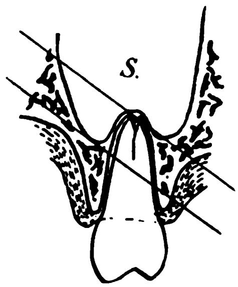


FIGURE 66.

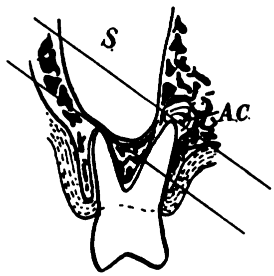


FIGURE 67.

FIGURE 68.

FIGURE 69.

Figure 66 shows molar roots projecting into the maxillary sinus. This will show in the Roentgen picture as in Figure 68. A thin layer of bone is seen surrounding the roots. Figure 67 shows roots not projecting into the sinus and an abscess on the palatal root of the molar. In such cases as shown in Figure 69, the end of the root as well as the abscess cavity may be projected inside the sinus.

FIGURE 70.

FIGURE 71.

Figure 70 shows part of the coronoid process of the ramus in the lower left-hand corner.

In Figure 71, part of the coronoid process is seen at the left hand side of the picture. This might be mistaken for the roots of a wisdom tooth with decayed crown.

duced by disease inside of the bone (Figure 72). Sometimes neighboring structures also play a part in making the picture confusing. When the exposure is made from too far below, a part of the hyoid bone is projected over the body of the mandible and when from too posterior a direction the cervical vertebræ may infringe upon the picture of the ramus (Figure 35 and 36). Directing the patient to extend the chin as far up as possible helps to overcome this trouble.

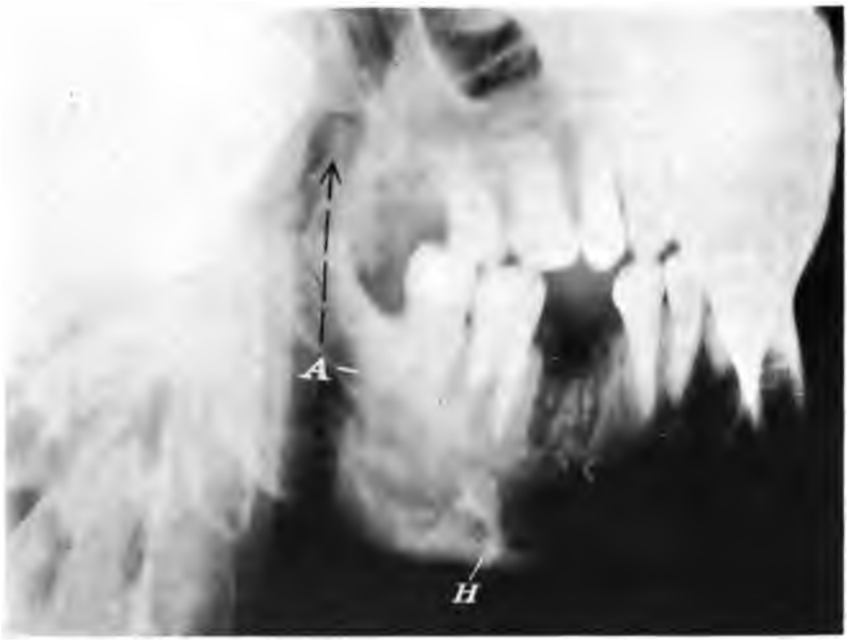


FIGURE 72.

Figure 72 shows a dark shadow starting at the coronoid process and running parallel with the spine. This is due to the nasal- and oral-pharyngeal space in the soft tissue (*A*). Note also hyoid bone (*H*).

In connection with some of the conditions affecting the tissues immediately surrounding the teeth, one should also bear in mind the fact that a tooth which is extremely radiopaque may often prevent the rays from recording certain abnormalities. An interradicular abscess between the three roots of a maxillary molar is, as a rule, extremely difficult to demonstrate in a Roentgen picture because the

roots obscure the abscess cavity (Figure 73). How to get a clear outline of the roots of multi-rooted teeth and to show both the lingual and buccal root canals in a tooth has been dealt with in the chapter

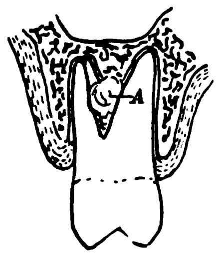
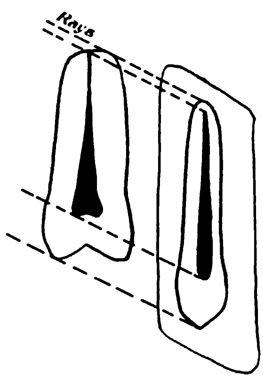


FIGURE 73.

Figure 73 shows an interradicular abscess on a maxillary molar, protected from Roentgen detection by the radiopaque roots.

on Technic (Figures 28 to 30). In doubtful cases one should always take more than one picture from different angles. A great many problems can easily be worked out by means of a little geometry. The fact that a root-canal filling in one picture may appear to extend to



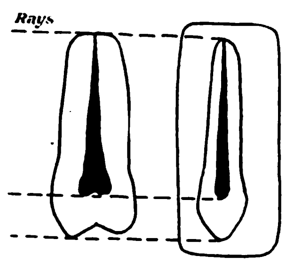


FIGURE 74*a*. FIGURE 74*b*.

In Figure 74*a*, angle of rays causes perfectly filled root canal to appear unfilled. Figure 74*b*, taken from a different angle, shows the actual condition.

the very end of the root, while in another it may be shown to be too short, is easily understood by looking at the illustrations in Figures 74*a* and 74*b*. If the angle of the rays is from a high position it would

appear as if the very apex was unfilled (Figure 74*a*), while an exposure made from a lower point of view would reveal the actual condition of the perfectly filled canal.

The intensity of the shadow of an apical abscess cavity is not altered so much by its contents as by its anatomical location. If the apex of a root protrudes into the center of the bone, the abscess cavity usually develops without destroying either the inner or outer alveolar plate (Figure 75). In many cases, however, an opening is formed through the outer cortical layer, and in very rare cases through the

FIGURE 75.

FIGURE 76.

FIGURE 77.

Figure 75 shows apical abscess in cancellous part, cortical layers undisturbed. Figure 76 shows buccal alveolar plate perforated by abscess. Figure 77 shows apex of root near surface. The abscess tissue, formed under the periosteum, has caused only a shallow depression; cancellous bone undisturbed.

inner cortical layer of the bone (Figure 76). In such cases the radiability of the bone is decreased to a greater extent than in the first illustration. If, however, the apex of the root is very close to the surface of the bone, it often happens that the infection at once finds its way to the outside and causes only a shallow depression in the bony wall (Figure 77). From this it is evident that only very slight evidence of abnormality would be visible in the Roentgen picture, and the texture of the bone would not be changed, since the bone trabeculæ which make up the cancellous part have not been disturbed.

PART III.

ROENTGENOGRAPHIC STUDY OF THE NORMAL ORAL TISSUES.

THE roentgenologist should have a thorough and detailed knowledge of the conditions which represent living normal anatomy at different periods of its development. The appearance of roentgenograms of the normal anatomical conditions of the oral cavity should, therefore, be studied first. In roentgenology it is not only necessary to be familiar with the external anatomy of the part to be examined, but also with the interior structure, because the Roentgen picture shows not only the outline, shape and prominences of the object but also the details of its internal or general structure.

When studying roentgenograms, it should be borne in mind that the various tissues change during life and that what is normal for one period of development is abnormal for another. Therefore, a knowledge of the different stages of development of the teeth and jaws should first be obtained.

I. THE DEVELOPMENT OF THE TEETH.

Preparation for the development of the teeth takes place as early as the middle of the second month of fetal life and prior to the formation of the bony structures which finally surround and give support to them. Following the line of the future alveolar ridge, the tooth band is formed in each jaw. It is continuous from one end to the other. Soon each

band throws out ten little buds, which develop into the enamel organs of the twenty deciduous teeth. While the enamel organ is developing, a change takes place in the connective tissue of the primitive jaw; the cells crowd into its concavity and become more highly specialized, forming the dentine organ. The two are surrounded by the dental follicle, which is formed from the base of the dentine organ. These three parts make up the tooth germ and develop highly specialized cells, which produce the various parts of a tooth. The enamel organ gives rise to the ameloblasts which form the enamel. The dentine organ deposits dentine at its periphery by means of odontoblasts, while the inner part remains as the dental pulp. The inner part of the dental follicle, at an advanced period, assists in the formation of the cementum by means of cementoblasts. The outer part forms a dense layer of bone, the future alveolar socket, called the lamina dura, while the remaining part finally evolves into the alveolo-dental membrane. The permanent teeth are formed in similar manner. Before the epithelial cord is broken, a bud is given off from the neck of the enamel organ of the deciduous tooth, which develops into the enamel organ of the corresponding permanent tooth. From the enamel organs of the incisors and cuspids arise the buds of the permanent incisors and cuspids, and from the enamel organs of the deciduous molars develop the buds of the bicuspids. The first permanent molar originates from a bud given off from the posterior extremity of the tooth-band, while the buds of the second and third molars emanate from the outer layer of the enamel organ of the first and second molars respectively.

Calcification of the Deciduous Teeth.—Calcification starts about the fourth month of fetal life. The future cutting edges of the incisors and the cusps of the posterior teeth are first affected. At the time of birth the crowns of the incisors are completely calcified and those of the molars almost so. Calcification of the deciduous teeth is completed at the end of the second year when the roots are fully formed and the apical foramina established. The diagram shown in Figure 78 gives an idea of how far the deciduous teeth have become calcified at a given age.

Eruption of the Deciduous Teeth.—Bone formation of the jaws starts about the middle of the second month of fetal life. Several centers of ossification appear and these soon unite so that the contour of the primitive jaw is established at the end of the second fetal month. The bone, first forming an open gutter beneath the tooth follicles, soon surrounds their lateral walls and finally encloses each follicle in a separate compartment, the sides arching over and almost completely enclosing the developing teeth. This condition is reached between the seventh and eighth months after birth. Almost simultaneously absorption of the bone begins, caused by the advancement of the erupting teeth. Most of the deciduous teeth erupt soon after their

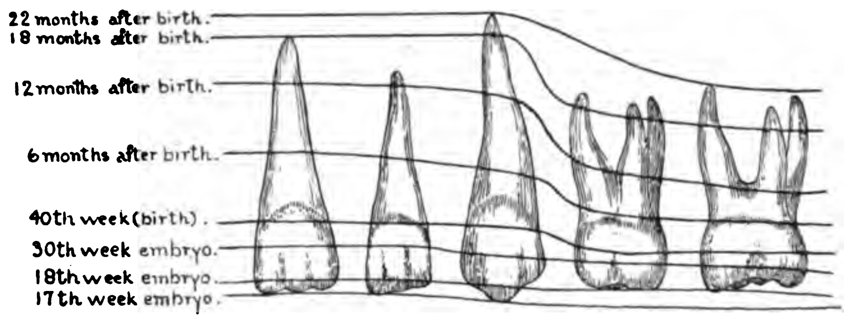


FIGURE 78.
Progress of Calcification of the Deciduous Teeth at Different Periods.

crowns have been completed. The region where the tooth is to erupt is marked by a whitish appearance, the mucous membrane is then penetrated and the cutting edge of the tooth appears in the mouth. As the crown advances the root becomes more and more calcified and in the majority of instances by the time the crowns are fully erupted the roots are also completely formed. At the same time rebuilding of the bone takes place which rapidly fills in about the roots. When the tooth has assumed its final position it is firmly supported by the newly-formed alveolar process. The teeth usually erupt in pairs. The central incisors come first, then the laterals and then the first molars. The cuspids appear next and finally the second

molars take their places. Generally at the end of the second year all the deciduous teeth are erupted.

Decalcification of the Deciduous Teeth.—The deciduous teeth remain intact only a short time and the process of decalcification, beginning

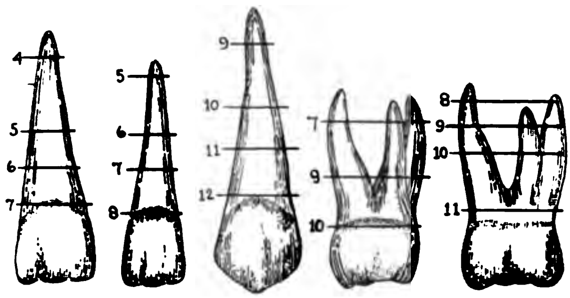


FIGURE 79.
Progress of Decalcification at Yearly Intervals.

about the fourth year at the apices of the central incisors, follows the order of their eruption. The process is completed in about three years, when the remainder of the tooth is cast off or shed. Figure 79 gives an idea of the relation between the process of decalcification and the age of the child.

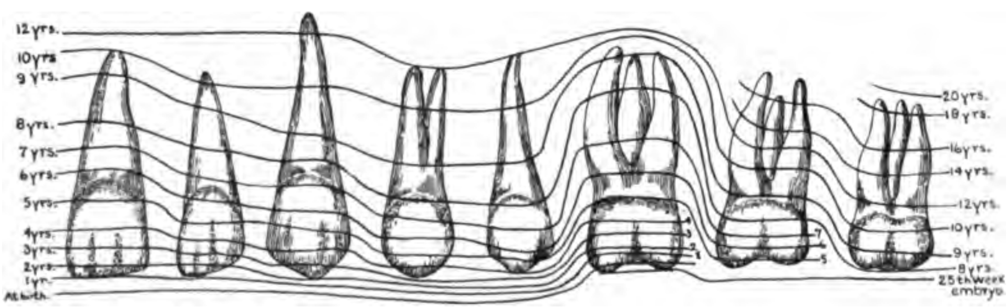


FIGURE 80.
Progress of Calcification of the Permanent Teeth.

Calcification of the Permanent Teeth.—Of the permanent teeth, it is the six-year molar in which calcification first begins, the cusps having started to calcify at the time of birth. The other teeth follow corre-

spondingly, as illustrated in Figure 80. All the teeth are fully calcified between the eighteenth and twentieth years.

Eruption of the Permanent Teeth.—The formation of the permanent teeth occurs above and below the deciduous ones and on the lingual side. They take up part of the space formerly occupied by the roots of the deciduous teeth, but the large crowns, having hardly enough room in the child's jaws, are pushed way down to the inferior border of the mandible, or high up in the maxilla. This is especially true of the cuspids, the roots of which are almost completely calcified at the time of the tooth's eruption. Gradually the crowns of the permanent teeth force their way to the surface. The first permanent molars erupt about the sixth year, behind the deciduous second molars. Then the crowns of the deciduous incisors are cast off, being succeeded by the permanent ones. The bicuspids take the place of the deciduous molars, which are lost between the tenth and eleventh years. At about the age of twelve, the second molars erupt. The cuspids replace the deciduous cuspids between the twelfth and thirteenth years and in the fifteenth year we find twenty-eight fully erupted teeth. Normally the third molars erupt between the eighteenth and twentieth years, but may be retained, according to the accommodations afforded by the growth of the jaws. They are always fully calcified before they make their appearance in the mouth. At the age of twenty, therefore, we should find in a normal case all the thirty-two teeth entirely erupted and the roots fully formed; that is, dentition should be completed.

Roentgen Appearance of the Teeth and Jaws during the Developmental Stage.—The developing tooth can only be recognized insofar as it has been calcified. The uncalcified part of the tooth germ is radiolucent, and as it takes up a considerable part of the bone it shows as a dark area in the Roentgen picture. The compartment containing the developing tooth is surrounded by a dense layer of bone, which can be compared with the lamina dura of the alveolar socket. This appears as a distinct light line surrounding the area which contains the tooth germ. It may be seen in the illustrations (Figures 82 to 85). The

progress of the tooth development and calcification can easily be studied in these pictures.

When the tooth finally erupts its apical foramen is still wide open. This funnel-shaped opening is illustrated in Figure 102. The dark area around the apex of such a tooth is a picture of the compartment containing the rest of the tooth germ, which takes care of the formation of the remaining unfinished part of the apex, and should not be mistaken for an area caused by a pathological process, as is often the case in unerupted third molars in young patients.

Decalcification of a deciduous tooth shows clearly in the picture as an irregular shortening of the root. There is generally no calcified tissue between the partly absorbed roots of the deciduous and the developing permanent tooth, and this area, being radiolucent, appears dark. This, if of normal size, should not be mistaken for bone destruction due to infection of the deciduous tooth.

	Tooth.	Calcification begins.	Calcification completed.	Eruption.	Decalcification begins.	Tooth shed.
		Fetal month.	Post-natal month.	Post-natal month.	Year.	Year.
Deciduous teeth.	Central incisor	4th	17th–18th	6th– 8th	4th	7th
	Lateral incisors	4th	14th–16th	7th– 9th	5th	8th
	Cuspids	5th	24th	17th–18th	9th	12th
	1st molars	5th	18th–20th	14th–15th	6th–7th	10th
	2d molars	5th–6th	20th–22d	18th–24th	7th–8th	11th–12th
		Year.	Year.	Year.		
Permanent teeth.	Central incisor	1st	10th–11th	7th– 8th		
	Lateral incisor	1st	10th–11th	7th– 8th		
	Cuspids	3d	12th–13th	12th–13th		
	1st bicuspid	4th	11th–12th	10th–11th		
	2d bicuspid	5th	11th–12th	11th–12th		
	1st molar	8th (fetal month)	9th–16th	6th– 7th		
	2d molar	5th	17th–18th	12th–14th		
	3d molar	9th	18th–20th	17th–20th		

The mandibular teeth precede those of the maxilla by short intervals.

Chronology of Human Dentition.—The approximate time of the beginning and completion of calcification, eruption, decalcification and loss of the teeth is given in the table on page 86. Variations from these dates are, however, very common. As it is often of great importance to know the exact condition, it is wise to diagnose the case by means of a roentgenogram, in order to decide on the advisability of extracting or retaining a deciduous tooth, to determine whether the root canals are completed, or to discover whether the apical foramen is widely open or closed.

Illustration of Tooth Development.

Figure 81.

Specimen: Fetus, six months old.

Roentgen Examination: Note Meckel's cartilage, bone formation of the jaws and small tooth plates indicating the beginning of calcification of the deciduous teeth.

FIGURE 81.

Illustrations of Tooth Development.

Figure 82.

Patient: A. H., girl, aged three years.

Roentgen Examination: All the deciduous teeth have erupted. The calcification of the permanent cuspid and first molar has extended about two-thirds the length of the crowns. Note the compartments containing the tooth germs and the lamina dura. The cusp of the first bicuspid is seen between the roots of the first deciduous molar in the mandible. A compartment can be seen between the roots of the second deciduous molar, but as calcification has not yet started in this tooth germ it is entirely radiolucent and shows as a dark area.

Figure 83.

Patient: H. S., girl, aged four years.

Roentgen Examination: Here we find further progress in tooth development. The roots of the first deciduous molar have been considerably absorbed. Calcification of the cuspid, first bicuspid and first permanent molar has further advanced. The roots of the latter are being formed and the lamina dura has changed to conform to the outline of the developing roots. Calcification of the second bicuspid has not yet started, but the compartment has increased in size.

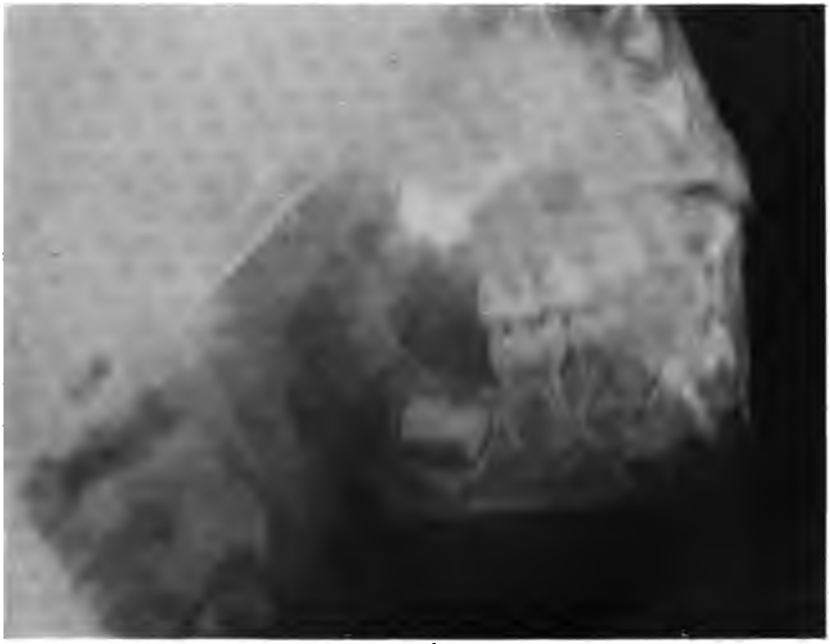


FIGURE 82.

FIGURE 83.

Illustrations of Tooth Development.

Figure 84.

Patient: E. L., boy, aged five years.

Roentgen Examination: Shows the first permanent molars partly erupted, but not yet in occlusion. The roots are not entirely formed. The crowns of both bicuspids are found between the roots of the deciduous molars, which have become partly decalcified. The second permanent molars have crowns half formed.

Figure 85.

Patient: W. C., girl, aged seven years and eight months.

Roentgen Examination: The development of the permanent teeth has progressed still further and the roots of the deciduous molars are two-thirds absorbed. Normal absorption is seen on the deciduous first molar. The second mandibular molar has become infected. Its roots are absorbed more than is normal at this age and the extensive radiolucent area between the permanent and the deciduous tooth is due to the pathological condition.

FIGURE 84.

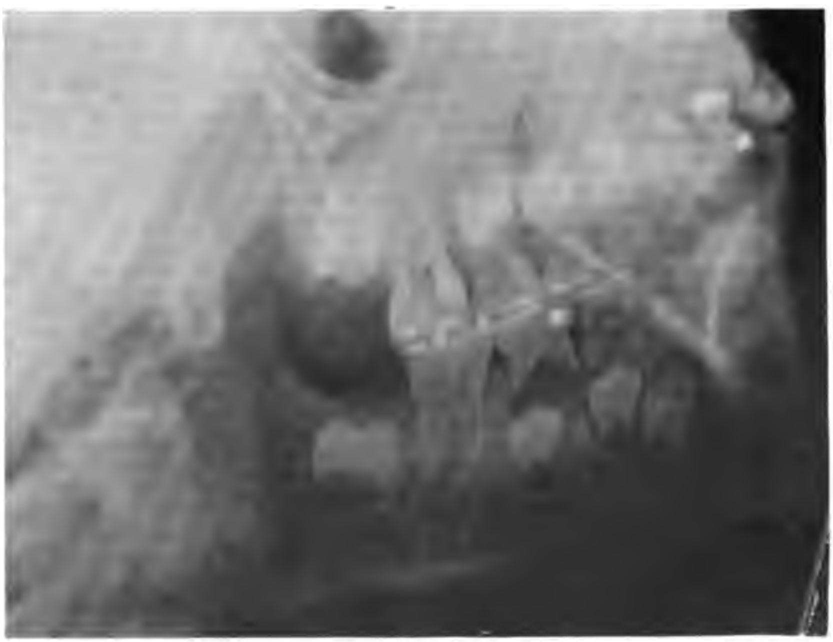


FIGURE 85.

Illustrations of Tooth Development.

Figure 86.

Patient: F. G., girl, aged ten years.

Roentgen Examination: The first deciduous mandibular molar has been shed and the first bicuspid is about to erupt. The roots of the deciduous second molar are almost entirely absorbed. The roots of the cuspid, first and second bicuspids and second permanent molar are still only partly formed, while the roots of the first permanent molar are completed. Note that the cusps of third molars have started to become calcified.

Figure 87.

Patient: G. S., girl, aged twelve years and eight months.

Roentgen Examination: All the deciduous teeth have been shed and the permanent ones have taken their places. The permanent second molars are just erupting. In the maxilla we can see the formation of the third molar, but in the mandible there is no sign of it.

FIGURE 86.

FIGURE 87.

II. THE NORMAL ADULT JAWS AND TEETH.

The two jaws, the maxilla and the mandible, are very dissimilar in their make-up. Not only does this apply to their shape and appearance, the former being irregular and the latter resembling, more or less, a flat bone, but especially do they vary in structure. They are both covered with periosteum, through which the bone receives part of its nourishment. In a Roentgen picture the periosteum is not visible if the bone is normal, but may become apparent when there is an exudate beneath it, or when it is inflamed or thickened.

The Maxilla.—The maxillary bone encloses a large cavity, the maxillary sinus. Its walls, therefore, are very thin. The teeth are contained in the alveolar process, which is made up of an outer and an inner plate of hard solid bone called cortex. The outer plate is very thin and frail, especially over the apices of the central incisors, cuspids and first bicuspids, so that abscesses occurring in these regions readily find an outlet to the surface and cause a minimum amount of bone destruction. Further back the bone becomes thicker and we usually find it massive over the second molar, where the zygomatic process has its origin. There are as many alveolar sockets as there are roots of teeth. These sockets in their normal condition are lined by a layer of dense bone, which is called the lamina dura and is shown in Figure 89. In a roentgenogram this dense, hard bone, which is very radiopaque, shows as a light line. Posterior to the teeth we find a rounded eminence, the maxillary tuberosity (Figure 91). The inner part of the bone is cancellous and consists of medullary spaces surrounded by trabeculæ of bone, which form a reticular structure. These trabeculæ, being radiopaque, show in the roentgenogram as light lines forming a lattice-work which encloses darker areas, representing the enclosed radiolucent spaces (Figure 90). The incisive foramen, which lies in the median line of the anterior part of the hard palate, is a radiolucent space, sometimes of considerable size. At certain angles of exposure its picture will be seen as a dark area in the neighborhood of the central incisors (Figure 62 to 65).

The Mandible.—The mandible consists of the body and two rami. The body, which supports the teeth, is the part with which we are particularly concerned, but the ramus is also important, as it is not infrequently affected by disease. The mandible is made up of an extremely thick, strong cortex, consisting of an inner and an outer plate, both of which are much stronger than those of the maxilla (Figure 93). In the molar region the bone is reinforced still more by the massive internal and external oblique lines. The construction of the cancellous part is like that of the maxilla and is shown in Figures 93, 95 and 97. The medullary spaces are sometimes of considerable size and should not be mistaken for a radiolucent area caused by disease. The ramus of the mandible is similar in make-up to the body.

The Mandibular Canal.—This canal starts from the mandibular foramen and can easily be traced in a good roentgenogram. The channel is dark, with a light line on each side, due to the cortical layer of bone lining it. The knowledge of its relation to the teeth is often of greatest importance in avoiding injury of the inferior alveolar nerve and artery. It passes forward immediately beneath the alveolar sockets in a horizontal direction until it finds an exit at the mental foramen (Figure 99). Here the main canal divides into a number of smaller ones, which pass forward to the sockets of the cuspids and incisors. Sometimes branches are given off which lead to the outside of the bone through small foramina in the mental fossa or at the lingual aspect of the bone around the genial tubercles. These foramina are called foramina lingualia and often appear in Roentgen pictures (Figure 100). The mental foramen lies below and between the first and second bicuspids, usually nearer the second one. The foramen, being a space and, therefore, very radiolucent, shows as a dark area, especially in an extraoral roentgenogram when it is nearer the plate (Figures 36 and 99), and should not be mistaken for an abscess area.

The Mandibular Joint.—This joint is made up of the condyloid process, the glenoid fossa and the joint disk placed between the two articulating surfaces. It is sometimes extremely difficult to get a satisfactory Roentgen picture of this joint, but when obtained it is of

great help in cases of fracture of the condyle, or dislocations (Figure 101).

The Normal Relation of the Teeth to the Jaws.—The jaw bones, the alveolar processes and the alveolar sockets have already been described and it has been pointed out that the latter are lined by a cortical layer of bone, the lamina dura, which shows as a light line in the Roentgen picture. Between this and the tooth is the periodontal membrane, by means of which the tooth is attached to the socket. This, being connective tissue, is of high radiolucency and therefore shows as a dark line which surrounds the entire root of the tooth (Figure 103).

The Teeth in Youth and Old Age.—The pulp chamber containing radiolucent tissue shows dark in the Roentgen negative. It is impossible to say from the appearance of the pulp chamber in the picture whether the pulp has been removed or not, unless there is indication of root-canal filling. The size of the pulp cavity depends upon the age of the tooth. At the time of eruption, the diameter is about equal to one-half of that of the crown, the root canal being widest at the apical part, where it presents a funnel-shaped opening (Figure 102). After the apical part is fully formed there is still a good sized root canal (Figure 103), but all through life a gradual reduction in size takes place due to the deposit of new dentine by the odontoblasts. This process is hastened, probably as a protective measure, by certain conditions such as caries and the presence of large metal fillings. In old age and sometimes earlier, on account of conditions such as those just mentioned, we may find the canals to be of minute size, or even obliterated entirely (Figure 104).

The Accessory Nasal Sinuses.—When taking pictures of the sinuses by an anterior-posterior exposure it is necessary to remember that the structures in the posterior part of the head throw shadows on the plate and must be differentiated from those lines and shadows which represent the nose and accessory sinuses (Figure 105). A stereoscopic picture gives the most accurate information in this respect, and it is very instructive to compare the interpretation made first by examination of one negative by itself with the appearance when viewed with its mate through the stereoscope. After a certain amount of

experience the different structures in the ordinary Roentgen picture can easily be interpreted (Figure 106).

In taking the Roentgen picture the probable thickness of the bone and diameter of the skull should be considered when figuring the exposure time and the penetration. The angle of the tube should be calculated so as to avoid overlapping of bony protuberances or dense ridges over the shadow of the sinuses. These vary in different individuals. The shadow of the petrous bone should fall over that of the inferior border of the orbit, while that of the basilar portion of the occipital bone should come over the shadow of the maxillary teeth. A lateral, or profile, exposure is not of great value, except in certain instances, such as localizing foreign bodies in a sinus, or to ascertain the depth of the frontal or sphenoidal sinuses. They are, as a rule, not satisfactory, because the sinuses of one side are superimposed over those on the other (Figure 110).

The Development of the Sinuses.—The sinuses vary considerably in size, according to the age of the patient. Sometimes in examining a child, it is important to find out whether a sinus exists, and if so to know its probable size. The frontal sinuses begin to develop at the age of one year. At this age they are very small and it is difficult to differentiate them from an anterior ethmoid cell. The ethmoid cells begin to develop during fetal life, but in infants they are so small that they are not easily distinguished in a Roentgen picture. The maxillary sinuses are present at birth and develop more rapidly than the frontal sinuses. They are, however, very close to the nasal wall and do not extend far in a lateral direction. At birth the lateral diameter is 2 mm. and the vertical diameter 3 mm. Even in older children we may still find that the lateral extension has progressed but slowly. At the age of two, the lateral measurement of the sinus is 8 mm. and at the age of five, 16 mm. At the ninth year the cavity extends into the zygomatic process, but not until all the permanent teeth have erupted does the floor of the sinus extend fully into the alveolar process. The sphenoid sinus is very small at birth and on account of the dense bone surrounding it, Roentgen pictures will not be satisfactory until the child is four or five years old, when the diameter in a sagittal plane is about 6 mm.

The Frontal Sinuses.—They vary greatly in size, shape and depth. There are usually two, each having a separate outlet into the nose (Figure 107). The septum between the two sinuses is seldom in the median line; it starts from the crista galli and proceeds usually in an oblique and deviated direction to one side or the other. All this can be seen in an anterior-posterior view (Figure 106). Portions of the sinuses often pass over the orbit and these may have complete partitions and separate outlets. They usually appear as a dark area over the supraorbital ridges and are often called supraorbital sinuses. In a lateral exposure we see light lines, starting from the supraorbital ridge and running in a posterior direction. These represent the highest part of the orbital plate (Figure 110).

The Ethmoid Cells.—The ethmoid cells (Figure 109) occupy the inner wall of the orbit. They are divided into anterior, middle and posterior cells. The individual cells vary greatly in size, the posterior ones (Figure 109) extending as far as the articulation of the ethmoid with the sphenoid bone and the anterior ones often extending into the roof of the orbit, within the frontal bone. The anterior cells can be seen in an anterior-posterior picture (Figure 106), while the posterior cells lying behind the orbital margin can often be seen to advantage in a lateral exposure.

The Sphenoid Sinuses.—They are two in number, generally of unequal size and irregular in shape (Figure 109). They lie in the body of the sphenoid bone. In an anterior-posterior view they appear in the middle of the nasal cavity. The nasal septum usually covers the bony partition between the two sinuses (Figure 106). In a lateral plate the sphenoid sinuses are situated beneath the posterior part of the hypophyseal fossa (old term, sella turcica) (Figure 110). If they are unequal in size, two outlines may be seen.

The Maxillary Sinuses.—These sinuses vary considerably in size, shape and capacity (Figure 105). Usually, in order to get an idea of their form, a frontal and a lateral Roentgen picture are necessary. The posterior and anterior walls are crossed by the alveolar nerves and vessels, which are generally contained in bony canals, into which they enter by special foramina. The bicuspids and molars are in

close relation to the antra and frequently the apices extend through the floors of these sinuses and cause small prominences, covered by a thin layer of bone and mucous membrane (Figures 68, 89 and 90). When healthy the antra appear even darker in the Roentgen picture than the other sinuses, on account of their size and depth; more intense even than the shadow of the orbits, which offer another means of comparison in the anterior-posterior view. In this view the upper external half is often concealed by the petrous portion of the temporal bone and the zygoma (Figure 106). In Water's position this is eliminated (Figure 108). In a lateral view the maxillary sinus is seen beneath the orbit, the relation of the teeth often being obscured by the shadow of the hard palate (Figure 110).

Illustrations of the Maxillary Bone.

Figure 88.

Specimen: Dry skull.
Photograph: Shows the outer aspect of the bone.

Figure 89.

Specimen: Dry skull with outer cortical plate removed and maxillary sinus exposed.

Photograph: Shows inner structure of bone and relation of the teeth to the maxillary sinus. Note the lamina dura surrounding the roots.

Figure 90.

Specimen: Dry skull shown in Figures 88 and 89.

Roentgen Examination: Shows the make-up of the inner part of the bone, and the relation of the teeth to the maxillary sinus. The thin layer of bone which encloses the sinus shows as a light line. The heavy white U-shaped line above the mesio-buccal root of the first molar represents the cortical bone of the zygomatic process, while the one starting at the lingual side of the incisors, curving up and then proceeding straight back across the apical third of the roots of the posterior teeth is a Roentgen reproduction of the palatal process of the maxilla.

FIGURE 88.

FIGURE 89.

FIGURE 90.

Illustrations of the Maxillary Bone.

Figure 91.

Patient: Mrs. L.

Roentgen Examination: Shows the maxillary tuberosity posterior to the third molar. Note its cancellous structure.

Figure 92.

Patient: Mrs. J. G. Sh.

Roentgen Examination: Shows second bicuspid, two molars and the maxillary tuberosity. A light line, starting above the apex of the bicuspid and continuing backward over the apices of the molars, is the wall of the maxillary sinus. Above this, approximately over the root of the second molar is a U-shaped line of light appearance and considerable width. This is a picture of the cortical plates of the zygomatic process. In between appears cancellous bone, which makes up the inside of this part. The white line, starting at the right side of the picture of the zygomatic process and proceeding to the right hand corner of the film is part of the bony wall of the nasal cavity.

Illustrations of the Mandible.

Figure 93.

Specimens: Cross-sections of mandible.

Photograph: Shows, on left, a cross-section through bicuspid region. Note the thick cortical bone and cancellous inner part; also the mandibular canal and mental foramen. On the right a cross-section of the anterior part of the mandible is shown.

FIGURE 91.

FIGURE 92.

FIGURE 93.

Illustrations of the Mandible.

Figure 94.

Specimen: From dry skull.
Photograph: Shows outer aspect of bone.

Figure 95.

Specimen: From dry skull, with cortical plate of mandible removed.

Photograph: Shows inner structure of bone. The lamina dura lining the alveolar sockets is especially well shown around the two bicuspid roots. The mandibular canal is partly exposed. Note the medullary spaces between the two roots of the first molar.

Figure 96.

Specimen: From dry skull shown in Figures 94 and 95.

Roentgen Examination: Shows also the inner make-up of the bone. The lamina dura is seen as a white line and is well shown between the bicuspid and molar. Note the relation of the third molar to the mandibular canal.

Figure 94.

Figure 95.

Figure 96.

Illustrations of the Mandible.

Figure 97.

Specimen: From dry skull with teeth extracted.

Photograph: Shows the make-up of the bone. Note the thick cortical layer at lower border and thinner cortical layer at alveolar margin. The sockets are also lined by cortical bone, the lamina dura.

Figure 98.

Specimen: From dry skull.

Roentgen Examination: Shows mandibular canal and small accessory canals leading to the roots of the teeth.

FIGURE 97.

FIGURE 98.

Illustrations of the Mandible.

Figure 99.

Patient: Mrs. I. J. Gl.

Roentgen Examination: Shows a large, round, dark area below the first and second bicuspid roots. This is the appearance of the mental foramen in an extraoral picture.

Figure 100.

Patient: Mrs. A. D. Ph.

Roentgen Examination: Routine examination shows, underneath the apices of two mandibular central incisors, a small dark point, indicating a very radiolucent area in the jaw. This is surrounded by rather dense bone, which appears light in the picture. Probably this is a foramen, transmitting nerves or vessels from the inside of the mandible to the soft tissues. Foramina of this size are often found in the mental fossa, as well as in the lingual aspect of the mandible in the same region. They are called foramina lingualia.

Figure 101.

Patient: Mrs. N.

Roentgen Examination: Shows normal mandibular joint, coronoid process and mandibular notch. The dark area over the ramus, almost parallel with its posterior border, is caused by contrast, due to the pharyngeal space. (See page 77.)

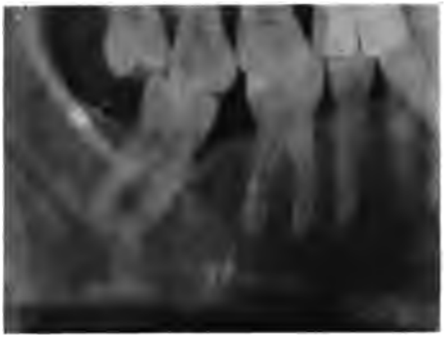


FIGURE 99.

FIGURE 100.

FIGURE 101.

Illustrations of Normal Teeth.

Figure 102.

Patient: Miss J., aged eleven years.

Roentgen Examination: Shows the roots of the first molar finished, roots of the second bicuspid and second molar not yet completed and the foramina wide open. Note size of the pulp canals.

Figure 103.

Patient: Miss G., aged twenty-four years.

Roentgen Examination: Shows teeth with pulp canals of normal size for young adult.

Figure 104.

Patient: Mrs. B., aged forty-eight years.

Roentgen Examination: Shows pulp chambers very much smaller and root canals decreased in size.

FIGURE 102.

FIGURE 103.

FIGURE 104.

Illustration of the Nasal Sinuses.

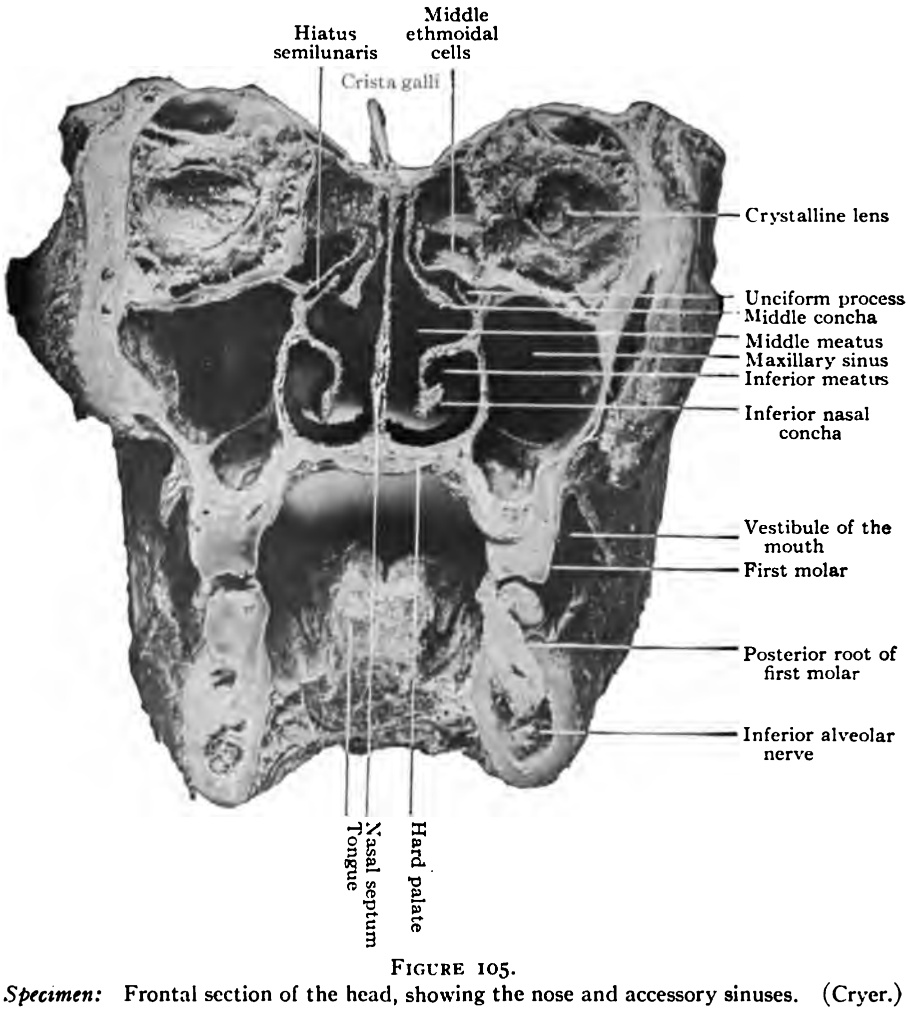


FIGURE 105.
Specimen: Frontal section of the head, showing the nose and accessory sinuses. (Cryer.)

Illustration of the Nasal Sinuses.

FIGURE 106.

Roentgen picture shows anterior-posterior view of the nose and accessory sinuses. *F.F.*, frontal sinuses; *S.O.*, supraorbital division of frontal sinus; *O.O.*, orbits; *E.E.*, ethmoid cells; *Sp.*, sphenoid sinus; *M.M.*, maxillary sinuses.

Illustrations of the Nasal Sinuses.

Figure 107.

Specimen: Frontal section of skull. (Cryer.) Anterior wall of frontal sinus is removed.

Photograph: Shows two large frontal sinuses extending from one zygomatic process of the frontal bone to the other. The thin septum between is not in the center, but is carried over to the left. The sinuses pass way upward, toward the frontal eminence. There are several partial septa running in various directions in both sinuses.

Figure 108.

Patient: K. H. T.

Roentgen Examination: Shows nose and accessory sinuses, Water's position. *M.M.*, maxillary sinuses; *O.O.*, orbits; *F.F.*, frontal sinuses; *R.*, right; *L.*, left.

FIGURE 107.

FIGURE 108.

Illustration of the Nasal Sinuses.

FIGURE 109.

Specimen: Sagittal section within nasal cavity, with the middle concha and portion of the cell walls turned up. (Cryer.)

Illustration of the Nasal Sinuses.

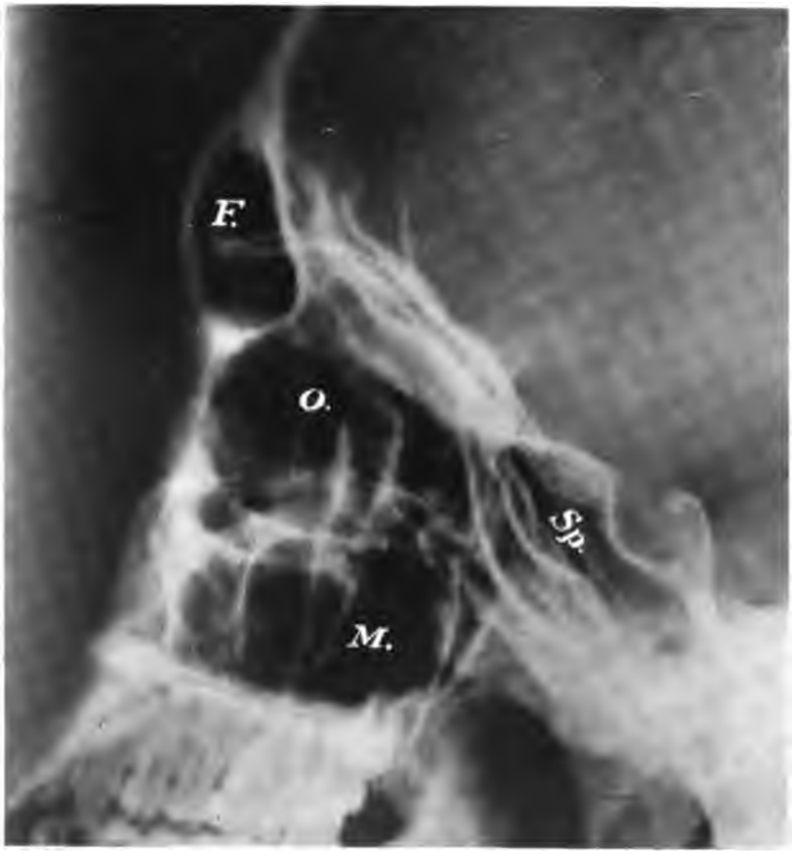


FIGURE 110.
Roentgen picture shows lateral view of the accessory nasal sinuses. *F.*, frontal sinus; *O.*, orbit; *Sp.*, sphenoid sinus; *M.*, maxillary sinus.

PART IV.

ROENTGENOGRAPHIC STUDY OF PATHOLOGICAL ORAL CONDITIONS.

AFTER having studied the appearance of the normal and healthy oral tissues as they appear in roentgenograms, we have a standard with which we can compare roentgenograms of the same parts changed by disease. The roentgenologist should have an intimate knowledge of the pathological conditions such as they appear postmortem, as well as under the microscope, although it is only the grosser pathology which can be recognized in the Roentgen picture.

We have come to rely so much on roentgenograms that we are apt to forget that the Roentgen method does not replace all the other means of diagnosis. It should be used in addition to digital and instrumental examination, visual inspection, transillumination, chemical, thermal and electrical tests.

In examining a roentgenogram with reference to disease, the interpretation depends a great deal upon a thorough and systematic search for abnormal conditions and upon the anatomical and pathological knowledge and the roentgenographic experience of the interpreter. The roentgenologist's judgment is rendered valuable by his ability to associate conditions seen in Roentgen plates with the changes which disease produces in the radiability of the tissues.

I. ABNORMAL DENTITION.

The use of the Roentgen ray is particularly applicable to the diagnosis of misplaced, unerupted, impacted, supernumerary or missing teeth. The radiability of a tooth is so much less than the surrounding

tissue that it stands out in a roentgenogram in a characteristic manner, which makes its size and shape easily recognizable. However, teeth often escape notice, especially if they are far from their normal position. This teaches us to be careful not to make a negative diagnosis from intraoral films, but to procure a roentgenogram which shows the entire extent of the maxillary bones.

Misplaced Teeth.—Unerupted teeth may be found in any part of the maxilla or mandible and it is important to include in the roentgenogram such places as may harbor them; namely, the nasal cavity, the maxillary sinuses, the lower border of the mandible and the entire ramus (Figures 112 and 320).

Unerupted and Impacted Teeth.—Roentgen pictures are not only very useful in determining whether a missing tooth is unerupted and impacted, but are also an aid in studying the relation of such a tooth to the surrounding parts, in order to decide on the operation which is required. The roentgenogram should, therefore, show the entire outline of the tooth, and include a fair amount of the surrounding tissues. Unerupted and impacted teeth may be found in various positions and although often lying dormant for years, they may at any time become associated with neuralgia or dull pains in any part of the head or neck. Their efforts to grow to the surface are usually intermittent, which accounts for the fact that the symptoms are not constant. The pressure which they frequently bring to bear upon the tissues toward which they are growing causes at times a physio-pathological absorption of the parts most easily dissolved. Part of the distal surface of the second molar root may become eaten away from the pressure of the cusp of an unerupted third molar (Figure 135). Judging by some cases carefully studied by the writer, the pain is not necessarily due to pressure against the obstructing part, but may be caused by development of the roots of an incompletely formed tooth in the opposite direction, when the inferior alveolar nerve is encroached upon. Such a case is shown in Figures 123 and 124.

The cause of these conditions is underdevelopment of the jaws, on account of which there is not room enough for all the teeth. The third molars, being the last to erupt, are principally affected.

The positions into which they grow vary greatly, and there are many variations in the shape and form. It is important for the dental surgeon to get accurate information of these conditions before attempting an operation. A roentgenogram which only shows part of the tooth is, of course, sufficient to reveal its presence, but is of no value to the operator. An intraoral film, if one can be used, is to be preferred because it is taken from an angle, which gives a more accurate picture of the actual relations than an extraoral picture, in which we generally get an overlapping and sometimes a distortion.

Classification.—Third molars may either be entirely unerupted, or partly erupted. The writer has used the following classification to designate the position of the tooth, the key to which is shown in the simple schematic drawing (Figure 111).

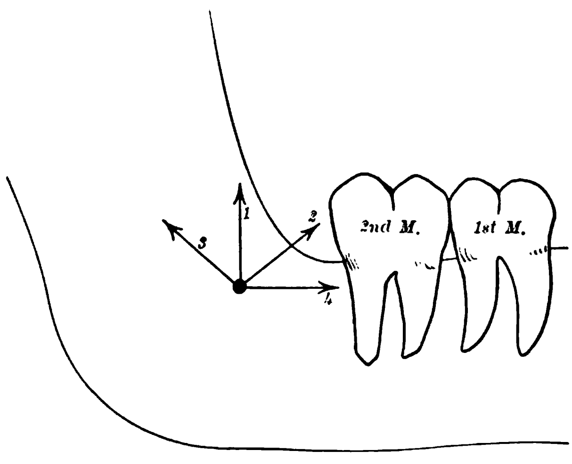


FIGURE 111.

Tooth.	Position.	Root formation.
Unerupted or partly erupted mandibular or maxillary third molar.	1. Upright 2. Mesio-oblique 3. Disto-oblique 4. Mesio-horizontal 5. Lingual or buccal displacement	(a) Complete, incomplete. (b) Curved, mesially or distally. (c) Fused or multiple. (d) Other abnormalities.

Infectious processes are often associated with impacted teeth and may start from a blind abscess on a neighboring tooth, from a pocket

on the gum, or through the blood. Partly erupted teeth are more liable to become infected than entirely unerupted ones on account of the entrance of the fluid of the mouth into the opening made by the erupting cusp. The infection passes rapidly into the deeper tissues, because the soft tissue does not adhere to the enamel of the crown, and leaves a pocket, which offers a splendid chance for infection. The process of inflammation sometimes takes a chronic course with intermittent, subacute attacks, or it may be acute from the start. It then involves the surrounding tissues and if it is in the back of the mouth may cause inflammation of the fauces and muscles about the ramus. Pharyngitis and trismus of the muscles of mastication are commonly sequels to an infection around an impacted third molar. The mandibular third molars are the teeth which are most frequently impacted, but the maxillary third molars are also often in an irregular position. In both jaws the tooth may become impacted beneath the equator of the crown of the second molar, but in the mandible there is an additional obstacle, the ascending ramus, which is the terminal boundary of the part of the mandible which accommodates the teeth. The irregularities causing impaction of the other teeth are generally premature loss or abnormal retention of the deciduous teeth. The cuspids are quite frequently impacted and unerupted, but any tooth, deciduous as well as permanent, may become an offender. This is evident from the case reports.

Retention of Deciduous Teeth, Due to Absence or Impaction of Permanent Ones.—In certain conditions the deciduous teeth remain and are not replaced by permanent ones. This happens when the permanent teeth are congenitally absent and also in cases in which the permanent teeth are prevented from eruption on account of impaction or misplacement. While we occasionally find that such deciduous teeth remain for a long time without becoming loose, we more often see in the Roentgen picture that the absorption of the roots proceeds as usual, whether the permanent tooth is impacted or missing.

Congenital Absence of Deciduous and Permanent Teeth.—There are many cases in which the permanent teeth are congenitally absent and usually there is a history that there were no deciduous ones either.

This is considered by many writers as a forerunner of reduction in the human dentition. It is especially the third molars and the lateral incisors which are found to be missing. The importance of Roentgen diagnosis in such cases is apparent, as it prevents the possibility of disturbances being caused under a bridge or a plate by the late eruption of a tooth which was believed to be absent (Figures 442 and 443).

Supernumerary Teeth.—Man normally has thirty-two teeth. This is a considerable reduction from the mammalian formula, which includes twelve incisors, four cuspids, sixteen bicuspids and sixteen molars in some species. It is believed that supernumerary teeth are a retrogression, or falling back upon the formula of a lower type, but there are also so-called rudimentary peg-shaped teeth which appear occasionally in the dental arch. These are caused by epithelial remnants, parts of the tooth band forming a primitive enamel organ into which a connective-tissue papilla grows, so forming, by an analogous process, as in tooth development, more or less well-formed supernumerary teeth.

Abnormal development of the teeth and tooth germs is also often the cause of dentigerous cysts. These are described in a special section under the heading "Follicular Cysts."

Illustrations of Misplaced Teeth.

Figures 112 *and* 113.

Patient: Mr. F. S. (courtesy of Dr. Gibbons).

History: One year previous to the discovery of the tooth the patient began to suffer periodically from headaches, no local pain whatever being present. He had a bad taste in the mouth every morning, and a fistula opening just back of the second molar was found, from which half a dram of pus was discharged in twenty-four hours.

Roentgen Examination: Figure 112 shows side view with probe inserted into the fistula. Figure 113 shows front view of same.

FIGURE 112.

FIGURE 113.

Illustrations of Unerupted and Impacted Teeth.

Figure 114.

Specimen: Shows partly erupted, impacted mandibular third molar, mesio-oblique position.

Figure 115.

Roentgenogram: Shows similar condition.

Figure 116.

Specimen: Shows unerupted, impacted mandibular third molar, mesio-horizontal position.

Figure 117.

Roentgenogram: Shows a similar condition.

Series of Mandibular Third Molars, Showing Different Positions.

Figure 118.

Roentgen picture showing partly erupted mandibular third molar, upright position, impacted under ramus, two roots. The dark area over the distal part of the crown indicates an infection.

Figure 119.

Roentgen picture showing partly erupted mandibular third molar, mesio-oblique position, two roots. Note relation to the inferior alveolar canal. Dislodging of the tooth caused hemorrhage from the inferior alveolar artery.

Figure 120.

Roentgen picture showing unerupted mandibular third molar, disto-oblique root fused. The dark area around the crown indicates the remnant of the enamel organ.

Figure 121.

Roentgen picture showing unerupted mandibular third molar, mesio-horizontal position, roots fused.

Figure 122.

Roentgen picture showing unerupted mandibular third molar, buccal displacement. The occlusal surface faces the buccal side, two roots. Note dark area around the crown, due to the enamel organ.

FIGURE 114.

FIGURE 115.

FIGURE 116.

FIGURE 117.

FIGURE 118.

FIGURE 119.

FIGURE 120.

FIGURE 121.

FIGURE 122.

Illustrations of Unerupted and Impacted Teeth.

Figure 123.

Patient: Mr. F. P., aged nineteen years.

History: Patient suffered for several years with periodic headaches, especially on the right side in the region of the frontal sinuses, with indefinite subjective symptoms of pressure in the back of the head. At times the pain disappeared entirely and then a period of suffering followed.

Roentgen Examination: Shows unerupted mandibular third molar with incompletely formed roots. Because the crown was not in contact with the second molar, the teeth were excluded as a cause of the symptoms. (See Figure 124.)

Figure 124.

Patient: Same person, two years later.

Roentgen Examination: Shows that the tooth has changed its position. The other three third molars were also found to be impacted.

Operation: It was decided to remove all four wisdom teeth, which resulted in complete relief from all symptoms. This demonstrates the fact that the pain was caused by the development of the roots of the teeth, which in the first picture are seen to have already reached as far as the inferior alveolar canal.

Figure 125.

Patient: Mr. R. B. F.

History: Had repeated infection around the left mandibular third molar. The last attack was the worst, being accompanied by large swelling, difficulty in swallowing, trismus of the muscles of the jaw and pus discharge around the tooth.

Roentgen Examination: Shows an impacted mandibular third molar, mesio-horizontal position, with large cavity in the crown, apparently involving the pulp and causing periapical infection, as indicated by the dark area around the apex of the root.

Figure 126.

Patient: Mrs. E. L., aged thirty-seven years. (Courtesy of Dr. J. M. Levy.)

History: Suffered from headaches for a considerable number of years without being able to secure any permanent relief.

Roentgen Examination: Shows impacted third molar, mesio-horizontal position.

Operative Findings: Second and third molars had to be extracted. The distal root of the second molar had been completely absorbed and the distal surface of the mesial root also showed evidence of absorption.

Figure 127.

Patient: Mrs. T. A.

Roentgen Examination: Shows third molar, mesio-oblique position. The roots of the second molar are impacted. The crown had been broken off in an attempt at extraction.

Figure 128.

Patient: Miss E. E.

Roentgen Examination: Shows unerupted third molar, mesio-horizontal position, causing impaction of the unerupted second molar.

FIGURE 123.

FIGURE 124.

FIGURE 125.

FIGURE 126.

FIGURE 127.

FIGURE 128.

Illustrations of Unerupted and Impacted Teeth.

Figure 129.

Patient: Miss B. D.

History: Complained of indefinite pressure in jaw which made her extremely nervous; also pain in back of neck.

Roentgen Examination: Shows unerupted mandibular third molar; mesio-oblique position, two roots curved distally and an abnormally low position.

Figure 130.

Patient: Dr. B.

History: Tooth gave no trouble for several months after its discovery, but suddenly began to cause neuralgic pain.

Roentgen Examination: Shows unerupted, impacted third molar, mesio-oblique position, fused roots curved mesially.

FIGURE 129.

FIGURE 130.

Illustrations of Unerupted and Impacted Teeth.

Figure 131.

Patient: Dr. E. S. W.

Roentgen Examination: Shows unerupted, impacted mandibular molar, mesio-horizontal position. The distal root of the second molar has been partly absorbed.

Figure 132.

Patient: Mr. E. T. S.

History: Complained of bad taste in mouth and occasional discharge of pus from a fistula on the face. Had an extraoral operation three years previous.

Roentgen Examination: Shows an unerupted third molar, disto-oblique and very low position. A dark area over this tooth and extending well into the ramus shows a radiolucent condition of the jaw, apparently caused by bone disease. Evidence of periapical infection on first and second molars. Diagnosis of chronic ostitis of the jaw, involving the unerupted third molar was made. The infection probably started from the pathological condition around the second molar.

FIGURE 131.

FIGURE 132.

Illustrations of Unerupted and Impacted Teeth.

Figure 133.

Patient: Mr. C.

History: Had two molars in left side of mandible extracted and replaced by an extension bridge, which was comfortable. No pain or symptoms of any kind.

Roentgen Examination: Routine examination revealed an unerupted molar in a downward mesio-oblique position below the bicuspid root.

Figure 134.

Patient: Miss R.

History: Periodic headaches in back of head for several years, quite severe and always on the right side.

Roentgen Examination: Unerupted maxillary third molar, mesio-oblique impaction. Pressure exerted against root of second molar caused this tooth to become tipped, as illustrated in the Roentgen picture.

Figure 135.

Patient: Dr. W. W. H.

History: Severe neuralgic pains in face for several weeks.

Roentgen Examination: Revealed partly erupted maxillary third molar, mesio-oblique impaction causing pressure absorption of distal surface of second molar, which was the cause of the pain.

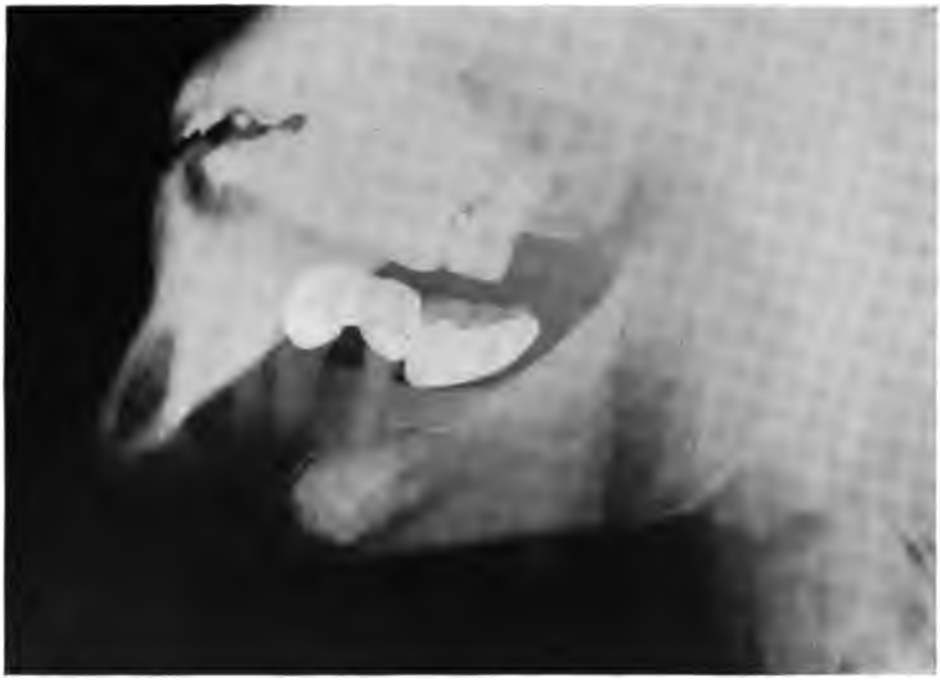


FIGURE 133.

FIGURE 134.

FIGURE 135.

Illustrations of Unerupted and Impacted Teeth.

Figures 136 *and* 137.

Patient: Miss E. C.

Roentgen Examination: Shows unerupted cuspid. Dark shadow around crown due to enamel organ. In Figure 136 cusp appears to be placed well over root apex of central incisor. In Figure 137, a film taken from a more distal position, the cusp is seen to cover only a very small part of the side of the root of the same tooth. The tooth, therefore, seems to move in the same direction as the tube and so is located on the lingual side of the roots of the other teeth.

Figure 138.

Patient: Miss C.

Roentgen Examination: Shows unerupted, impacted maxillary cuspid. Pressure exerted on the root of the lateral incisor caused it to protrude.

Figure 139.

Patient: Miss M. S., aged fourteen years.

Roentgen Examination: Cuspid did not erupt and was found in the position shown in the Roentgen picture. Dark area around crown of the tooth due to enamel organ.

Figure 140.

Patient: Mrs. H. H. P.

History: Maxillary cuspid never erupted. The lateral incisor was sensitive to touch at times.

Roentgen Examination: Shows a radiopaque object, which is the missing tooth. Its cusp is in contact with the lateral incisor.

Figure 141.

Patient: Mrs. J. C.

History: Had pain and swelling in the cuspid region of the mandible. Pus was discharged from a fistula.

Roentgen Examination: Shows unerupted cuspid. The dark area around the crown of the tooth indicates bone infection and the appearance of the crown itself points to decay of the tooth. A small dark area at the end of the bent root indicates periapical infection.

FIGURE 136.

FIGURE 137.

FIGURE 138.

FIGURE 139.

FIGURE 140.

FIGURE 141.

Illustrations of Unerupted and Impacted Teeth.

Figure 142.

Patient: Miss R.

History: Had several old roots in maxilla and pus discharge from various sinuses.

Roentgen Examination: Shows two unerupted cuspids. The mottled appearance of their crowns indicates caries, due to the infection from the roots. Compare the appearance with that of other impacted cuspids.

Operative Findings: The two cuspids were surrounded by abscess tissue, probably due to infection from the other teeth, causing decay of their crown.

Figures 143 *and* 145.

Patient: Miss A. W.

History: Gum in anterior part of maxilla had been inflamed for a long time and was discharging pus from a fistula.

Roentgen Examination: A radiopaque object which, from its outline, may be taken for an incisor, is shown in the picture (Figure 144). In Figure 146 the condition of the maxillary bone is shown, and from the decreased density of the irregular outline we conclude that the bone is extensively infected.

Figure 144.

Patient: Miss A. W.

Roentgen Examination: Shows unerupted, malposed cuspid. The tooth appears normal.

FIGURE 142.

FIGURE 143.

FIGURE 144.

FIGURE 145.

Illustrations of Unerupted and Impacted Teeth.

Figure 146.

Patient: Miss C. F., aged about twelve years.

Roentgen Examination: Shows deciduous mandibular second molar impacted, with roots absorbed and second bicuspid unerupted. The bicuspid is prevented from erupting on account of the retention of the deciduous tooth.

Figure 147.

Patient: Miss W., aged about ten years.

Roentgen Examination: Shows maxillary deciduous second molar impacted, with roots absorbed. The permanent teeth are present and show normal development.

Figure 148.

Patient: Master K., aged about twelve years.

Roentgen Examination: Shows mandibular deciduous second molar unerupted and impacted, the roots being absorbed. The second bicuspid seems to have a rudimentary form, or lies sideways. It is prevented from erupting.

Figure 149.

Patient: Miss L. B.

Roentgen Examination: Shows unerupted deciduous incisor, lateral view. The impaction of this tooth prevents eruption of the permanent central incisor.

Figure 150.

Patient: Dr. C.

History: Several teeth, in various parts of the mouth, were missing.

Roentgen Examination: Shows unerupted bicuspid, disto-oblique position. The dark area around the crown of the tooth is a picture of the radiolucent compartment containing the enamel organ of the tooth.

Figure 151.

Patient: Miss G. S., aged twelve years.

Roentgen Examination: Shows unerupted, impacted mandibular second bicuspid. The impaction is probably due to early loss of the deciduous second molar.

FIGURE 146.

FIGURE 147.

FIGURE 148.

FIGURE 149.

FIGURE 150.

FIGURE 151.

Illustrations of Retained Deciduous Teeth; Permanent Teeth Missing.

Figure 152.

Patient: Mr. G., aged twenty-six years.

Roentgen Examination: Shows that the retained deciduous tooth has an absorbed root, the permanent tooth being absent.

Figures 153 *to* 156.

Patient: Mr. W. C. B., aged twenty-eight years.

Roentgen Examination: On the right upper side (Figure 153) the deciduous second molar has been retained. Its roots are entirely absorbed and both bicuspids are absent. On the left upper side (Figure 154) both deciduous molars have been retained. The same is true of the left lower side (Figure 156). In none of the pictures is there any evidence of the permanent teeth. Also, on the right lower side (Figure 155) bicuspids are absent. The deciduous teeth have been shed, except for a small piece of root.

Figure 157.

Patient: Miss B. T., aged fourteen years.

Roentgen Examination: The retained deciduous second molar shows only slight absorption of the roots. There is no bicuspid present.

FIGURE 152.

FIGURE 153.

FIGURE 154.

FIGURE 155.

FIGURE 156.

FIGURE 157.

Illustrations of Retained Deciduous Teeth and Impacted Permanent Ones; Missing Teeth.

Figure 158.

Patient: Miss M. C.

Roentgen Examination: Shows deciduous cuspid partly absorbed. Permanent cuspid unerupted and impacted.

Figure 159.

Patient: Mrs. H.

Roentgen Examination: Shows that the unerupted bicuspid is growing in the wrong direction and is impacted. The deciduous molar, which has been retained, shows absorption of the roots.

Figure 160.

Patient: Mrs. B.

Roentgen Examination: Shows that the permanent cuspid is unerupted and impacted and the deciduous cuspid shows absorption of the root. The permanent cuspid is pressing against the root of the lateral incisor, causing its crown to tip distally.

Figure 161.

Patient: Miss Sy.

Roentgen Examination: Shows absence of both maxillary lateral incisors.

Figure 162.

Patient: Master M., aged twelve years.

Roentgen Examination: Shows both deciduous and permanent lateral incisors missing on left side. The picture shows the left permanent central incisor and next to it the deciduous cuspid root partly absorbed, and the unerupted permanent cuspid about two-thirds formed.

FIGURE 158.

FIGURE 159.

FIGURE 160.

FIGURE 161.

FIGURE 162.

Illustrations of Supernumerary Teeth.

Figure 163.

Patient: Mrs. W.

Roentgen Examination: Shows unerupted third molar and rudimentary fourth molar, erupted distally to the second molar.

Figure 164.

Patient: Mr. J. F.

Roentgen Examination: Shows first molar supplied by bridge and behind third molar a small rudimentary fourth molar.

Figure 165.

Patient: Miss E. L., aged seventeen years.

History: The right mandibular cuspid failed to erupt, although the orthodontist had kept a space open for it for a considerable length of time.

Roentgen Examination: Shows a tooth about to erupt, but from the formation of its crown it is shown to be a bicuspid. As two bicuspids had already erupted this is a supernumerary tooth. The unerupted cuspid was also revealed in a much more anterior position.

Figure 166.

Patient: Miss J. F. M.

History: Left mandibular second bicuspid was sensitive to touch.

Roentgen Examination: Shows unerupted supernumerary bicuspid, causing pressure absorption of the apex of the second bicuspid. Note area indicating the enamel organ around crown of the tooth.

Figure 167.

Patient: Mrs. L. H. J.

Roentgen Examination: This picture, taken through the space formed by the zygomatic arch and sigmoid notch of the ramus of the mandible, shows a rudimentary fourth molar.

Figure 168.

Patient: Mr. M. W. M.

Roentgen Examination: Shows unerupted third molar in mesio-oblique position. Two roots fused and in close relation to the inferior border of the mandible. Tooth has caused pressure absorption of the roots of the second molar. Over and slightly posterior to the third molar lies another, a supernumerary molar, the position of which is either a lingual or buccal displacement.

FIGURE 163.

FIGURE 164.

FIGURE 165.

FIGURE 166.

FIGURE 167.

FIGURE 168.

II. DISEASES OF THE HARD TISSUES OF THE TEETH.

The diseases of the hard-tooth tissues are nearly always obvious, with the exception of affections of the root ends, which will be discussed in connection with periapical infections. There are cases, however, where the Roentgen ray is useful in diagnosis.

Attrition.—This is a physiological process, the tooth being worn down from mastication. In these days, when most of our food is cooked and soft, we rarely find bad cases of attrition, but with our ancestors it was the greatest etiological factor in the involvement of the pulp and of alveolar abscesses, as is evidenced in the skulls of the ancient Egyptians and various tribes of the old as well as the new world. Attrition also occurs sometimes on single teeth, due to malocclusion or loss of the supporting back teeth. From a roentgenogram we can get an idea of how far the process has progressed toward the pulp chamber and how much the pulp has receded. It is important to know this when restoring lost tooth substance, or when making appliances to protect the tooth from further harm.

Traumatic Injuries.—Teeth which have received traumatic injuries from blows, falling, accidents, etc., should always be roentgenographed, because fractures occur quite frequently below the surface of the gum and cannot always be diagnosed by digital examination. Anterior teeth are most frequently injured and the line of fracture is generally in a horizontal direction. Roots to which porcelain crowns are attached by means of posts, however, split vertically. If the vertical fracture lies in a labio-lingual or bucco-lingual plane, it can be easily demonstrated on a Roentgen film, while the disto-mesial fracture is not always visible in a roentgenogram.

Caries.—This most frequent dental disease is, as a rule, easily diagnosed, but at times decay beneath the gum margin, or under a filling or crown, causing neuralgia or sensitiveness to heat, cold and sweets, may be only found by means of the Roentgen ray. The Roentgen method of examination has not yet come into general use for locating obscure cavities in routine examination, but judging from incidental findings in systematic search for infectious lesions, it might

be well worth while to use the Roentgen ray for this purpose. Timely recognition is, of course, of great value, not only in cases where there is indefinite pain, but particularly to prevent the infection of dental pulps. Caries may be recognized in a roentgenogram as a dark area, due to increase of radiability, which is due partly to decalcification of the dentine by bacterial ferments and partly to actual loss of tooth substance. When caries extends deep into the tooth substance it produces a protective reaction, which probably is also called into activity if large fillings are inserted without an insulating layer of cement. The irritating action of the infection, as well as chemical and thermal influences stimulate deposit of secondary dentine, which, of course, decreases the size of the pulp chamber. This can be easily recognized in any Roentgen picture of the teeth.

Cavity Fillings.—Different filling materials have a different degree of radiability. Porcelain cement fillings often appear the same in a picture as an unfilled cavity (dark), on account of their almost equal radiolucency. Oxy-phosphate cements are more radiopaque and, therefore, show lighter in the Roentgen picture. Metal fillings, of course, are completely radiopaque and gutta percha offers a similar barrier to the rays.

Every dental roentgenologist could produce a large number of films showing poor gold, amalgam, cement and gutta-percha fillings and gold inlays. Large overhangs injuring the peridental membrane and alveolar bone, as well as lack of contact points, giving occasion for the formation of so-called food pockets, are the most frequently observed evils (see illustrations).

Odontomata.—A tooth tumor is composed of one or more of the tooth tissues. It may be attached to another tooth, or it may be a separate structure in the form of two or more teeth fused together (see "Follicular Cysts").

Illustrations of Attrition.

Figure 169.

Specimen: From dry skull.

Photograph: Shows mandible with attrition of the teeth, the pulp of the first molar having become exposed at the mesio-lingual cornea

Figure 170.

Specimen: From dry skull shown in Figure 169.

Roentgen Examination: Shows close relation of the occlusal surface to the pulp chamber. A dark area at the ends of the roots of the first molar, due to pulp infection, is revealed.

Figure 171.

Patient: Mr. McK.

Roentgen Examination: Shows that the pulps have receded a considerable distance on account of attrition, due to lack of support of the teeth, on account of the loss of bicuspids and molars.

Figure 172.

Patient: Mr. T. B.

Roentgen Examination: Attrition of the anterior teeth has caused the pulps to recede.

Figure 173.

Patient: Mr. P. G.

Roentgen Examination: Shows the relation of the pulp of the molar to the worn-off occlusal surface.

FIGURE 169.

FIGURE 170.

FIGURE 171.

FIGURE 172.

FIGURE 173.

Illustrations of Traumatic Injuries of the Teeth.

Figure 174.

Patient: Mr. W.

History: Patient had received a blow, which had necessitated removing the pulp of the central incisor and filling its root canal. An abscess formed, however, causing swelling of the gum and soreness.

Roentgen Examination: Shows fractured root with root-canal filling in coronal part. The dark area between and around the fracture indicates alveolar infection.

Figure 175.

Patient: Mr. R. S. C.

History: Patient was hit with hockey stick. There followed some pain, considerable swelling of the gum and soreness of the central incisor.

Roentgen Examination: Shows fractured root.

Figure 176.

Patient: Miss R. S.

History: Patient received an injury to the anterior teeth in the maxilla while playing basket-ball.

Roentgen Examination: Shows no fractured tooth, but both central incisors are pushed out of their sockets, as indicated by the space between the lamina dura and the tooth roots.

Figure 177.

Patient: P. P., boy, aged twelve years.

History: The maxillary central incisors were accidentally injured three weeks previous to examination. There was no pain. Teeth discolored.

Roentgen Examination.—Pictures were taken after splint was attached to teeth and one canal filled. Horizontal fracture shown on both teeth. One canal is filled. Apicoectomy was performed.

Figure 178.

Patient: Mr. McK. C.

History: Patient was in motorcycle accident. The anterior teeth in the maxilla were slightly broken at edge, the left maxillary incisor was very tender and there was a slight swelling over the gum.

Roentgen Examination: Shows fracture of root. The small dark area at the apex shows the beginning of an apical infection.

Figure 179.

Patient: Mr. W. Y.

Roentgen Examination: Shows root of second bicuspid fractured in a vertical direction, probably due to pressure from the post of the Richmond crown.

FIGURE 174.

FIGURE 175.

FIGURE 176.

FIGURE 177.

FIGURE 178.

FIGURE 179.

Illustrations of Dental Caries.

Figure 180.

Patient: Miss W.

Roentgen Examination: Shows pulps in the two central incisors very much receded on account of decay, which is revealed in both the mesial and distal parts of the crown.

Figure 181.

Patient: Miss P.

History: Patient complained of earache on right side, and also said she occasionally had "face-ache" on same side. No pain in the teeth. She consulted two dentists, who could find no cause.

Roentgen Examination: Shows large decayed area under filling at distal side of the right mandibular second bicuspid. A dark area at the apex of the tooth indicates that infection had spread from the pulp to the bone.

Result of Operation: After extraction of the tooth and curettage of the bone the symptoms disappeared promptly.

Figure 182.

Patient: Mr. C. M. R.

History: Had arthritis in hip and knee for two and a half years. Teeth apparently sound.

Roentgen Examination: The dark area under the filling in the distal side of the left mandibular first bicuspid indicates dental caries, which affected the pulp, causing periapical infection, as indicated by the dark shadow around the apex.

Figure 183.

Patient: Mrs. F. A. S.

History: Obscure neuralgia, especially in right side of maxilla.

Roentgen Examination: Shows a dark area on the cervical part of the root of the mandibular second molar and a cavity at the distal side, all concealed under the gum.

Result of Operation: Extraction of the tooth stopped the neuralgia entirely.

Figure 184.

Patient: Mrs. F. A. S.

History: Pain in left side of mandible.

Roentgen Examination: Shows dark area on distal side of left mandibular molar, indicating decay in close proximity to the pulp.

Figure 185.

Patient: Mrs. W. V. B.

History: Pain on left side of mandible when taking hot or cold food.

Roentgen Examination: Shows dark area, indicating tooth decay, under filling on distal side of left mandibular molar.

FIGURE 180.

FIGURE 181.

FIGURE 182.

FIGURE 183.

FIGURE 184.

FIGURE 185.

Illustrations of Filling Materials and Types of Poor Cavity Fillings.

Figure 186.

Roentgen Examination: Shows a maxillary central incisor with a gutta-percha root canal filling. On the distal side a porcelain cement filling has been inserted. Compare the radiability of the tooth with the porcelain fillings and the gutta-percha.

Figure 187.

Roentgen Examination: Shows maxillary incisors with oxy-phosphate cement filling in the right lateral incisor, two gold fillings in each central incisor and another gold filling in the mesial surface of the left lateral incisor.

Figure 188.

Roentgen Examination: Shows amalgam filling with rough overhang in first molar, extending way down between the teeth and causing inflammation of the alveolar bone between the teeth.

Figure 189.

Roentgen Examination: Shows extensive overhang at the mesial side of a mandibular second molar. This overhang was the cause of an inflammatory reaction of the investing tissues.

Figure 190.

Roentgen Examination: Shows lack of contact point between the two molars and roughness of the filling on the mesial side of the second molar at the cervical margin.

Figure 191.

Roentgen Examination: Reveals irregular protrusions of the fillings in many places. These were the cause of a gingival irritation, of which the patient complained.

FIGURE 186.

FIGURE 187.

FIGURE 188.

FIGURE 189.

FIGURE 190.

FIGURE 191.

Illustrations of Odontomata.

Figure 192.

Patient: Mrs. I. A. V.

History: Patient had frequent attacks of severe neuralgia.

Roentgen Examination: Shows unerupted, impacted mandibular third molar. The third molar in the maxilla is also unerupted and has an extension of round appearance and radiopaque character at the distal part of its neck.

Operative Findings: When the maxillary third molar was removed it was found that a round tumor, made up of dentine and covered with cement, was fused to its distal side.

Figure 193.

Patient: Mrs. E. B.

Roentgen Examination: Routine examination for infectious foci revealed an odontoma in the mandible in the region of the third molar, which had not erupted.

Operative Findings: The odontoma was made up of two mandibular molars grown together, one in upright and one in transverse position. The first tooth was well formed and the other also had the general appearance of a mandibular molar.

FIGURE 192.

FIGURE 193.

III. DISEASES OF THE DENTAL PULP AND THEIR SEQUEL, PERIAPICAL INFECTION.

Abnormal Size, Shape and Number of Root Canals.—These conditions can only be diagnosed by means of the Roentgen method and before treating a root canal, no matter what the condition is, a Roentgen picture is absolutely necessary. The patient and the dentist will save much time and expense if the exact condition is determined beforehand. Not only is it important to know whether the tooth roots are straight or bent, whether the number of the canals is normal or abnormal, whether the apical foramen is unfinished or contains several outlets, whether the canals are accessible to the very ends, or whether obstructing deposits of secondary dentine prevent successful treatment, but also it is important to ascertain whether a diseased pulp has affected the peridental membrane, the tooth root and the surrounding bone, as the treatment of each of these cases would vary widely.

Pulp Nodules and Calcifications.—These are the only changes in the pulp which can actually be demonstrated in a roentgenogram. In the case of secondary dentine the outline of the root canal is changed, while pulp nodules and calcifications cause a direct alteration in the radiability of the pulp. The nodules may be round or oblong and calcifications may close up the entire lumen of the root canal. On account of their radiopacity, pulp stones are easily recognizable in the Roentgen negative as light areas in the root canal (Figures 204–208).

Inflammatory Processes and Necrosis of the Dental Pulp.—These are microscopic and primarily cause no change which would affect the radiability of the tissue. As a matter of fact we cannot even get a picture of the pulp itself, what we see being the pulp cavity in the tooth. It is sometimes possible, however, to make a diagnosis of a diseased pulp by finding one of those conditions which we know to be a cause of pulp disease; for example, decay beneath a filling (Figure 211), a pus pocket reaching the apical end of an otherwise sound tooth (Figure 214), or infection spreading from a neighboring tooth (Figure 215). In a patient with clinical symptoms generally associated with pulp disease, of which there are no definite local mani-

festations, a condition such as described will help to localize the offending tooth and the Roentgen finding would be a weighty factor in the evidence when making a diagnosis. It is sometimes possible, however, to diagnose a diseased pulp by finding a condition which is known to be a sequel to pulp infection. We may discover a dark area around the root of a tooth which has no history or Roentgen evidence of pulp removal. The area may be well defined and very large, or may only appear as an indistinct zone of induration (Figures 211 to 213). Both conditions indicate that the pulp in the tooth has become diseased, causing a reaction in the periapical tissues.

Periapical Infection.—The first changes in the periapical tissues, due to pulp disease, I believe to be simply due to an infiltration of leukocytes and lymphocytes. This is a reaction such as we find in the tissues around any abscess, or in the neighboring structures around any infection. When the injurious agent, in our case the infected pulp tissue, is removed, the lymphocytes disappear and the tissue returns to its normal state. This inflammatory change in the peridental membrane, however, causes an increase in its size, especially near the seat of the infection, which can be recognized in the Roentgen picture as a dark shadow around the root. Very soon, however, the peridental membrane becomes infected, resulting in an acute or proliferating periodontitis.

The seat of the infection is generally located at the apical foramen, the natural outlet of the root canal, but occasionally it occurs between the roots of a multi-rooted tooth, particularly when the pulp chamber has been penetrated by a burr or root-canal instrument, or by decay. In such cases it is called an interradicular infection (Figure 218). Sometimes the infection occurs at the side of a tooth root, where there is a lateral foramen or an artificial opening made by instrumentation. This is called a lateral infection (Figure 216). The pathological processes hereafter described are the same, whether they are located at the apex, the side or between the roots, and the infection will be called an apical, lateral or interradicular abscess, or granuloma, as the case may be, to designate the seat of the lesion.

Periapical infection originating from a diseased dental pulp may

follow either of two chains of pathological changes. The first is of a destructive nature and begins with a reaction causing all the symptoms of acute inflammation, while the other from the beginning is characterized by a mild and chronic reaction, which starts and continues without giving any local symptoms.

Acute Periapical Infection.—This type starts with a violent reaction. The increase in the size of the peridental membrane, due to accumulation of leukocytes, is so rapid that the tooth may be pushed out of the socket. In a Roentgen picture this is demonstrated by an increase in the size of the space between the lamina dura of the alveolar socket and the tooth root (Figure 219). At this stage the infection is spoken of as an acute periodontitis. After a very short time, purulent exudates accumulate, the cells of the peridental membrane and surrounding bone become destroyed, an abscess cavity filled with pus, forms in the bone and the condition is then called an acute alveolar abscess. In other cases very little bone destruction takes place, because the pus at once finds an outlet *via* the Haversian canals, which penetrate the outer cortical layer of the bone. When the pus collects under the periosteum a reaction sets in immediately, causing a widespread serous infiltration of the soft parts, cheek or neck. Finally it burrows a channel through the soft tissue, forming a fistula into the mouth, nose, maxillary sinus, or outside of the face.

The Roentgen picture differs widely in cases which have the same clinical appearance. If the abscess forms at once under the periosteum, leaving the bone intact, the bone in the Roentgen picture appears almost normal (Figures 221 and 222). If the pus accumulates in the cancellous part of the bone there is a stage when there is no actual dissolution and the roentgenogram shows only a general haziness. In most cases, however, the bone is extensively destroyed before an outlet is formed and the radiolucent abscess cavity appears as a dark area in the picture. The size of the area indicates the amount of bone involved (Figure 220).

Chronic Periapical Infection.—After the acute abscess, the climax of the process of destruction, Nature makes an attempt at repair and the violent symptoms disappear, but unless the cause (for example,

a diseased pulp or necrotic root apex) is removed, the condition becomes chronic. In this stage it may last for an indefinite period with the fistula discharging pus when the destructive process becomes more active, or closing up for a time when the defensive system predominates, only to reopen with more or less marked symptoms when the suppurative process again predominates. A roentgenogram of chronic periapical infection shows a dark area, indicating the radiolucent cavity in the bone, filled with granulation tissue. Roentgenographically this condition cannot be distinguished from proliferating periodontitis and dental granulomata (Figure 223).

Proliferating Periodontitis, Blind Abscess or Dental Granuloma.— Not until the Roentgen picture came into use for dental work was it discovered that pulpless teeth, although apparently firm and sound and giving no discomfort, are very frequently the cause of chronic inflammatory processes, harbored in the maxillary or mandibular bones. Since the pathology and bacteriology of these symptomless lesions have been studied more carefully, and since we know that they may become foci of somatic diseases, we have discovered the grave fact that these septic conditions are extremely deceiving and may be more dangerous than abscesses of an acute and violent character. We also realize now the importance, when examining a patient, of making a most careful search for such lesions, which can usually be diagnosed only by the Roentgen method.

The difference between an acute alveolar abscess and a blind abscess, or dental granuloma, should be clearly understood. The former is a suppurative inflammation and involves a process of destruction of the peridental tissues, dissolving them into pus. The latter is a reaction to a mild infection, stimulating inflammatory new growth, as seen in certain specific infections, such as the tuberculous granuloma (tubercle) and the syphilitic granuloma (gumma, syphiloma). The blind abscess, or granuloma, begins and continues to grow without giving any local symptoms. The defensive system of the body takes care of the slow but continuous formation of pus, and the only reason that the infection does not become more evident clinically is because of the wonderful blood supply of the jaws, and the prompt formation

of a barrier protecting the neighboring structures. Active suppuration, therefore, does not occur at first, but an exacerbation may change the pathological picture so as to simulate a typical acute alveolar abscess. This is generally caused by an additional burden placed on the defensive system of the body, as, for example, in sickness or pregnancy, when we quite often find that the chronic lesion becomes active and acute. The result of local influences also bears out the same fact. A tooth with Roentgen evidence of infection, which has given no symptoms for years, very often starts an active process when opened up, admitting oxygen, and the writer has observed three cases of blind abscesses, which probably had existed for years without the patient's knowledge, become suddenly acute from Roentgen exposure during routine examination of the teeth. If used therapeutically this exposure would be considered a stimulating dose of Roentgen rays (Figures 224 and 225). This all goes to prove that these conditions, though giving no clinical evidence and recognizable only by Roentgen examination, are unquestionably latent infections and important harbors of bacterial proliferation.

When speaking of a blind abscess, or granuloma, we must think of a focal accumulation of leukocytes and lymphocytes in the newly-formed granulation tissue, rather than of a cavity filled with pus.[1] Sometimes a dental granuloma is described as being a tumor, but this is not correct, as it is distinctly of infectious origin and histologically presents a picture of chronic inflammation. The disease, of course, affects the bone, and as it is principally this bone involvement which is demonstrated in the Roentgen picture, it is of the greatest importance to make a careful study of how this tissue is affected by the disease. The lamina dura of the alveolar socket is first attacked and destroyed, after which the disease spreads into the medullary spaces, destroying the trabeculæ of the cancellous part of the bone. In this way there is formed in the bone a cavity, which is filled by the granuloma. The outer or inner plate of the alveolar process may become involved, the Haversian canals being first attacked and injured, as seen in Figure

[1] Thoma, K. H.: A Histo-pathological Study of the Dental Granuloma and Diseased Root-end, Jour. Nat. Dent. Assn., 4, 1075–1090.

226. The many small holes on the surface of the bone indicate osteoporosis. This generally results in loss of the part of the cortical bone overlying the abscess cavity, so that a hole is formed in the outer wall of the bone (Figure 227). Still another condition may develop when the apex of the root is very close to the surface. The Haversian canals may be attacked at first and then a shallow cavity in the surface of the bone may form, leaving the cancellous inner part intact, the granuloma forming in the shallow depression and underneath the soft tissues. The two latter types of granulomata can often be recognized by a sensation of tenderness from digital pressure on the gum over the apex of the root.

Another difference exists between an ordinary granuloma and an incipient cyst, which is formed from the epitheliated granuloma. In the former the bone is involved in an irregular manner, while in the latter a cortical layer of bone of regular outline is formed around the granuloma, in response to the pressure exerted by the cyst contents. The first type, if it develops into a more extensive lesion becomes a granulating ostitis, while the other develops into a peridental cyst, both of which conditions will be described later. (Page 214.)

When Roentgen examinations are made, these various conditions should be borne in mind. It is loss of bone which shows in a Roentgen picture, the radiolucent area appearing as a dark shadow. The intensity of this shadow varies greatly, but to my mind has nothing to do with the content. Its appearance is the same whether it is filled with air, blood serum, pus or granulation tissue. The difference is principally due to its anatomical relations, as described above. If the cavity is in the center of the bone, surrounded by the two thick, outer cortical walls, we get a picture which is not so distinct as that produced when there is a perforation of one of the bony plates of the jaw, when the picture will show principally the outline of this opening. If there is a shallow cavity on the surface of the bone, the cancellous make-up of the inner part, which is intact, is usually discernible throughout the shadow of the diseased area in the Roentgen picture. In the ordinary granuloma the outline of the diseased area is usually irregular and gradually merges into the normal tissues (Figure 230), while in

the incipient cyst we always get a typical picture—a dark area surrounded by a light line, due to formation of cortical bone, as previously described (Figure 231). If a large number of cholesterin crystals are formed in an incipient cyst they decrease the radiability and give the appearance of an abscess which is almost healed (Figure 232). The granuloma on the lateral incisor shown in this illustration was pathologically examined by the writer and was found to be filled with cholesterin crystals.[1] The size of an abscess cavity can be estimated from the picture. It is an indication of the seriousness of the involvement of the surrounding tissues (Figures 233–238). There is an exception to be made, however, in the bicuspid and molar region of the maxilla, especially if these teeth protrude into the maxillary sinus. It should be borne in mind that when there is only a very thin film of bone over the roots of these teeth there is no chance of extensive bone destruction and cases which show the smallest shadow are more liable to be the cause of sinus disease than larger areas separated from the maxillary sinuses (Figures 66–69).

Complications Caused by Periapical Infection.—When considering the frequent occurrence of these localized bone abscesses around the teeth, it is surprising that one does not more often encounter a spreading of the infection and extensive involvement of the jaws. Cases of extensive bone involvement are shown in Figures 242 and 243 and in the section on Ostitis. The infection also remains, as a rule, localized on one tooth, and one seldom finds involvement of the adjoining teeth. Occasionally, however, such cases do occur, as illustrated in Figure 240, in which we see a pulpless lateral incisor with partial root-canal filling and periapical infection. The picture of the abscess cavity shows that it is connected also with the root of the central incisor, the root canal of which has never been opened. The patient, after being told of the condition, did not believe that it was of any consequence as it had never given her any trouble. Nothing was done to either of the teeth. She returned two days later with well-marked symptoms of pulpitis in the central incisor. A similar case is

[1] Thoma, K. H.: A Histo-pathological Study of the Dental Granuloma and Diseased Root-end, Jour. Nat. Dent. Assn., **4**, 1075–1090 (Figure 20).

shown in Figures 239 and 241. Infection and pus discharge sometimes persist after extraction of a tooth. This may be due to the fact that two teeth were involved. If, for example, treatment had been undertaken in the case shown in Figure 240 without having a Roentgen diagnosis made, probably only one tooth would have been extracted, since the other gave no clinical symptoms. The abscess on the second tooth would, of course, have continued as long as the tooth was retained. Such a case is illustrated by a patient who had a mandibular second bicuspid extracted. Pus, however, continued to discharge through the alveolar socket where the tooth had been removed (Figure 244).

Bone infection is not always eliminated by simply extracting the tooth. This is shown by the case illustrated in Figure 245. The patient said that the maxillary lateral incisor had been opened and the pulp removed two years previous to examination. The root was perforated and finally extracted, a year and eight months later. When seen by the writer a boil had formed near the wing of the nose. The roentgenogram in Figure 245 shows a dark area, which indicates the site of the original abscess cavity. When opening it from the labial side of the gum it was found to be filled with inflammatory granulation tissue, containing a slight amount of pus.

Infection of the maxillary sinuses, bone infections and cysts occur frequently from periapical infections and will be described in another section.

Effects of Periapical Infection on the Root Apex.—Periapical infection, especially if it is of long standing, causes changes in the cementum of the tooth. Nutrition is usually disturbed, the cells of the apical part of the peridental membrane may become destroyed and the cementum, which is very porous and easily absorbs the products of inflammation, becomes pus-soaked and filled with bacteria. In this condition the tooth is an obnoxious foreign body, which Nature tries to eliminate by osteoclastic absorption. This starts on the surface of the cement, which then presents a roughened appearance. Marked indentations are formed, and the cement and later also the dentine, become absorbed. The recognition of this condition in a Roentgen picture is of the greatest importance, because it indicates that only one kind of treatment

is possible, either root resection or extraction. The apex in such a state is a dead piece of bone and, like a sequestrum, has to be removed before healing can take place. There is no medicinal treatment which can restore to such a tooth its normal condition. If the periapical infection is of recent origin, the outline of the root is usually well defined and clear in a roentgenogram, which shows that the cementum has not yet been attacked. When the cement becomes affected, an indistinct outline of the apex of the root may be observed at first. Later we can see actual loss of part of the root, due to osteoclasia. Various stages of absorption are seen in Figures 246–250.

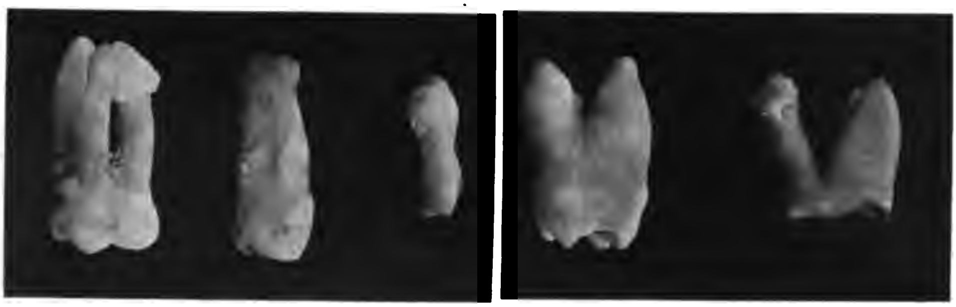


FIGURE 194.

Hypercementosis in various stages may be found in connection with some of these infections at the apex of the roots (Figure 194). It is due to the stimulation of cementoblasts which have survived. Figure 251 shows a case with hypercementosis on the mesial root. Loss of tissue can be noticed at the very apex, but on both sides of the root end a decided enlargement has taken place. This often happens, because at the very apex the cementoblasts have been destroyed, while on the side they remain vital, or are newly supplied from the remaining normal peridental membrane. This thickening, or bulging of the root is called exostosis and makes extraction of the tooth an extremely difficult operation. If the condition occurs in the mesio-distal direction it is easily recognizable in the roentgenogram by the abnormal outline of the root of the tooth.

Condensing Ostitis and Bone Repair Following Treatment of Periapical Infection.—The Roentgen picture not only helps in diagnosing properly the extent of the involvement of the periapical tissues; that is, the bone and tooth root, but also furnishes a means of checking up the progress of bone repair, no matter whether the treatment was medicinal, electrolytic or surgical. It should be remembered, however, that sometimes the treatment only decreases the virulence or concentration of the infective bacteria. This changes the pathological picture—a condensing ostitis sets in, and there is a tendency toward formation of compact bone, spoken of as sclerotic, eburnated, or scar bone, which contains no marrow spaces except small channels for the blood supply. Condensing ostitis starts in the region farthest removed from the original source of infection, and one should not be too optimistic, therefore, when the Roentgen picture records a change. A decrease in the size of the abscess cavity, as revealed by the Roentgen ray does not imply that complete restoration can be expected. Scar bone is of almost uniform appearance in the roentgenogram (Figures 253 to 257). It is very light, but as long as a dark area remains near the root apex the condition should be classified as condensing ostitis rather than restoration to the normal.

In cases in which healing is progressing and actual bone repair is taking place, we see in the roentgenogram bone bridges filling the former abscess cavity uniformly. These first appear after six weeks, but it takes from one to two years in the adult for complete restoration to occur (Figures 258 to 263).

Sclerotic Bone.—This is a condition in the jaw due to replacement of the cancellous bone by hard, indurated, or eburnated bone. It may be caused by one of several diseases, such as condensing ostitis, bone repair following fractures, or tumor, (osteoma). Sclerotic bone is very radiopaque, as it is entirely compact—not cancellous, as is the normal bone of the jaws.

Illustrations of Abnormal Size, Shape and Number of Pulp Canals.

Figure 195.

Specimen: Prepared skull, reproduced by courtesy of Dr. Hopewell Smith.

Photograph: Shows normal pulp canals in permanent teeth.

Figures 196 to 199.

Roentgen Examination: Shows abnormally formed roots. Figure 196, cuspid with extreme mesial bend in root. Figure 197, second bicuspid with root bent distally. Figure 198, first bicuspid with irregularly shaped root. (Note fractured root of second bicuspid.) Figure 199, mandibular molar with very abnormal roots. The root canals conform to the shape of the roots.

Figure 200.

Roentgen Examination: Shows bifurcation of canal in apical part of mandibular first bicuspid.

Figure 201.

Roentgen Examination: Shows two root canals in mandibular second bicuspid.

Figure 202.

Roentgen Examination: Shows accessory canal in apical part of root of a maxillary central incisor, with gold crown. The accessory canal branches off mesially.

Figure 203.

Roentgen Examination: Shows pulp canal of mandibular second bicuspid and second molar wide open in a patient about eleven years of age.

FIGURE 195.

FIGURE 196.

FIGURE 197.

FIGURE 198.

FIGURE 199.

FIGURE 200.

FIGURE 201.

FIGURE 202.

FIGURE 203.

Illustrations of Pulp Nodules and Calcifications.

Figure 204.

Microscopic Specimen: Dental pulp in situ. Stained with Mallory's phosphotungstic acid, hematoxylin. Several pulp nodules are shown in the picture.

Figure 205.

Patient: Mrs. V. G. L.

History: Had attacks of neuralgia on left side of face at intervals. For three days had been in severe pain, which was especially located in the ear and zygomatic region. Blocking of the posterior-superior alveolar nerves with novocain stopped the pain at once.

Roentgen Examination: Shows nodules in the pulp chambers of the maxillary second and third molars.

Result of Operation: Removal of the pulp and pulp stones relieved all symptoms.

Figure 206.

Patient: Mrs. J. B., aged about seventy-five years.

History: Suffered for years from severe neuralgic pains. The extraction of two suspicious teeth, performed some time ago, had no beneficial effect. Blocking of the inferior alveolar nerve stopped the pain.

Roentgen Examination: Shows pulp nodules in both remaining molars.

Result of Operation: No recurrence of attacks after removal.

Figure 207.

Patient: Miss H.

Roentgen Examination: Shows calcareous deposits in pulp canals of all teeth.

Figure 208.

Patient: Miss E. S.

History: Patient had been suffering for years with very severe neuralgia on both sides of the face.

Roentgen Examination: Shows pulp stone in pulp chamber of left mandibular first molar, as well as in other teeth not reproduced.

Result of Operation: Removal of the pulp stones did not relieve the condition.

FIGURE 204.

FIGURE 205.

FIGURE 206.

FIGURE 207.

FIGURE 208.

Illustrations of Pulp Infections and Necrosis.

Figure 209.

Patient: E. B.

History: Patient had been suffering a great deal with pain in the mandible for two nights.

Roentgen Examination: The only pathological condition which could be seen was a shadow, indicating a cavity at the distal side of the mandibular lateral incisor. This cavity was covered by hypertrophied gum tissue. The decay is seen to extend very close to the pulp canal. This, considered with the history, led to a diagnosis of pulpitis.

Figure 210.

Patient: Dr. G. M. G.

History: Patient had severe neuritis in left side of mandible.

Roentgen Examination: Shows a large cavity at the distal surface of the first molar. The decay extended near the pulp and caused inflammation.

Figure 211.

Patient: Miss P.

History: Earache on right side and occasionally what she called "faceache" on the same side. No pain in teeth.

Roentgen Examination: Shows large dark area indicating decay under filling of right mandibular second bicuspid; also dark area at apex of root. From these findings we may conclude that the pulp is diseased.

Operative Findings: Pulp found to be necrotic.

Figure 212.

Patient: Miss T.

Roentgen Examination: Routine examination shows periapical infection on all four mandibular incisors. There are porcelain cement fillings in all four teeth and also two gold fillings. There is also evidence of metal under some of the porcelain fillings. Diagnosis of pulp disease in all four incisors was made. Whether the pulp disease was due to the action of the porcelain cement or to some other cause could not be determined.

Figure 213.

Patient: Miss F. G.

History: Slight pain at angle of jaw. Examination of mouth showed well cared for teeth with large fillings. There was also tenderness of submaxillary lymph glands.

Roentgen Examination: Shows a well-defined dark area on the roots of the mandibular first molar. The dark area under distal part of the filling indicates decay. The conclusion from these findings is that the pulp has become infected from the decay, causing periapical infection.

Operative Findings: Pulp putrescent, with very marked odor of decay.

FIGURE 209.

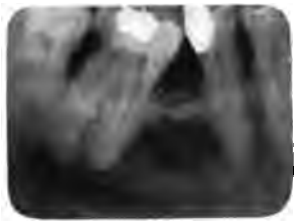


FIGURE 210.

FIGURE 211.

FIGURE 212.

FIGURE 213.

Illustrations of Pulp Infections and Periodontal Abscesses.

Figure 214.

Patient: Dr. J. A.

History: Left mandibular first molar was extracted on account of pain on that side of the jaw. The symptoms, however, did not disappear. Pain grew more intense.

Roentgen Examination: Shows sockets of extracted teeth. The dark area leading to the apex of the mesial root of the second molar, *A*, indicates that a pocket had existed. From this pocket the infection had spread to the root apex, causing pulpitis.

Figure 215.

Patient: Mr. H. R.

Roentgen Examination: Right mandibular lateral incisor shows evidence of root-canal filling. A dark area at the apex, indicating extensive periapical infection, is seen to extend over to the next tooth. This, the central incisor, was sensitive to the heat test. It was found to contain an infected pulp. As the tooth had no cavity and was otherwise perfectly normal the pulp infection must have been caused by the apical infection from the lateral incisor.

Figure 216.

Roentgen Examination: Shows "lateral granuloma" caused by perforation at the side of the root.

Figure 217.

Roentgen Examination: Shows periapical infection.

Figure 218.

Roentgen Examination: Shows "interradicular abscess" caused by decay perforating the pulp chambers.

FIGURE 214.

FIGURE 215.

FIGURE 216.

FIGURE 217.

FIGURE 218.

Illustrations of Acute and Chronic Periapical Infections.

Figure 219.

Roentgen Examination: Shows increase in the size of the dark area around the root of the second bicuspid, ordinarily occupied by the peridental membrane. This is Roentgen evidence of pericementitis of the entire membrane.

Figure 220.

Patient: Mr. G. T.

History: The maxillary central incisor had recently been filled and the tooth started to ache. Examination showed the left central incisor extremely loose and tender, the two neighboring teeth being in a similar condition. The gum was swollen and the lip protruded.

Roentgen Examination: Shows dark area, apparently starting from left central incisor. No indication of root canal work. This led to the conclusion that the pulp had become infected and caused an acute abscess. As indicated in the picture a large amount of bone was destroyed before the pus broke through to the surface.

Figure 221.

Patient: Miss F. B.

History: While having the teeth regulated, the right maxillary lateral incisor became very sore and there was a large swelling on the gum over this tooth.

Roentgen Examination: Reveals only slightly rarefied area around root apex of lateral incisor.

Operative Findings: Tooth was opened into under general anesthesia and found to be putrescent. After lancing the gum, a great deal of pus escaped.

Figure 222.

Patient: Miss R. M. P.

History: Had extensive swelling under lip for several days. Submaxillary lymph gland was very tender and badly swollen. Temperature, 101° F.; pulse, 102. Lateral incisor sore to percussion.

Roentgen Examination: Although there was tremendous swelling, the Roentgen picture shows no diseased area in the bone as would be expected with such severe symptoms.

Operative Findings: The pulp of the lateral incisor, when opened into, was found to be highly putrescent. An incision on the labial side of the gum released about an ounce of pus. The apex of the tooth must have been very close to the surface, because the pus evidently caused no destruction of the bone, but pierced the bone and periosteum (which accounts for the absence of pain), and accumulated under the gum.

Figure 223.

Patient: Mr. A. W. G.

History: Patient had discomfort from right mandibular second bicuspid for a long time. When examined there was swelling on the gum and severe pain.

Roentgen Examination: Shows large-sized abscess cavity on the bicuspid, the pulp of which had probably been infected for a long time, judging from the amount of decay of the crown.

FIGURE 219.

FIGURE 220.

FIGURE 221.

FIGURE 222.

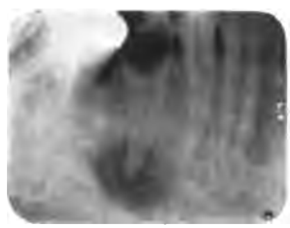


FIGURE 223.

Illustrations of Periapical Infection.

Figure 224.

Patient: Mrs. F. M.

Roentgen Examination: Shows dark area extending around mesial root of mandibular first molar and over to distal root. Two days after the roentgenogram was made, during routine examination, the patient started to have pain, the tooth was tender on percussion and exacerbation started from no apparent cause other than Roentgen stimulation.

Figure 225.

Patient: Mrs. K. A.

Roentgen Examination: In routine examination the condition of the left maxillary lateral incisor was found to be as seen in Figure 225. The tooth had not given any symptoms for years. The dark shadow over the apex is not very intense, but indicates the diseased area in the bone. Several Roentgen exposures were made of this tooth to get exact information as to the condition and, although nothing else was done, the patient started to have pain and swelling the next day, which resulted in a suppurating inflammation.

Figure 226.

Specimen: Dry skull showing a case of osteoporosis of the outer alveolar plate over the decayed roots of the first molar.

Figure 227.

Specimen: Dry skull showing a maxillary second bicuspid, a pulpless tooth, which had been crowned. Note the discoloration of the root, the abscess cavity with large perforation in the outer wall, and the enlarged Haversian canals surrounding it.

Figure 228.

Specimen: Dry skull showing a maxillary central incisor with abscess cavity at apex of tooth. The outer plate has been perforated so that the root is exposed.

Figure 229.

Specimen: Dry skull showing an abscess cavity around the roots of the mandibular first molar, involving the outer cortical plate. The roots have been almost exfoliated and are of the type so frequently left in the jaw because they seem to "cause no trouble," or because their removal "would make the cheek fall in."

FIGURE 224.

FIGURE 225.

FIGURE 226.

FIGURE 227.

FIGURE 228.

FIGURE 229.

Illustrations of Periapical Infection.

Figure 230.

Patient: Mr. D.

Roentgen Examination: Shows typical shadow of periapical infection. Note that the change from diseased to normal tissue is gradual and diffuse.

Figure 231.

Patient: Mr. H. Ho.

Roentgen Examination: Shows a typical shadow of an incipient periodontal cyst over the apex of the lateral incisor. Note the characteristic light line surrounding the diseased area.

Figure 232.

Patient: Mrs. K.

History: Left maxillary lateral incisor had been treated a long time ago. It had given no symptoms for years.

Roentgen Examination: Shows circular area over apex of lateral incisor. This is not very much darker than the surrounding bone and at first was taken for an old periapical infection showing bone repair. The excised granuloma was examined microscopically and found to contain large numbers of cholesterin crystals.[1]

[1] Thoma, K. H.—A Histo-pathological Study of the Dental Granuloma and Diseased Root-end. Jour. of Nat'l. Dental Assoc., **4**, 1075-1090, Figure 20.

FIGURE 230.

FIGURE 231.

FIGURE 232.

Illustrations of Different Sizes of the Abscess Area.

Figure 233.

Patient: Mr. X.

Roentgen Examination: Shows pulpless cuspid, partial root-canal filling and a slight shadow at the very apex of the root. This is the beginning of a proliferating periodontitis.

Figure 234.

Patient: Mr. F.

Roentgen Examination: Shows a dark area at the apex of the first bicuspid, a picture of the radiolucent granuloma.

Figure 235.

Patient: Mrs. C. H. C.

Roentgen Examination: Shows two dark areas. The one at the apex of the lateral incisor is not so distinct as in Figure 236 because the cortical plates of the bone remained intact. It represents an apical granuloma situated inside the bone. The other dark area, above the central incisor at its mesial side represents the incisive foramen, as was ascertained in another picture.

Figure 236.

Patient: Mrs. R.

Roentgen Examination: Shows large and distinct dark area, indicating an apical granuloma with perforation of the outer alveolar plate. The root canal is partly filled and divides into two branches at the apex.

Figure 237.

Patient: Mrs. J. L. S.

Roentgen Examination: Shows a large shadow, indicating a granuloma, which was caused by the lateral incisor.

Operative Findings: Apicoectomy was performed and a large cavity, filled with inflammatory granulation tissue, was found in the bone. The outer alveolar plate had not been perforated.

Figure 238.

Patient: Mrs. W. H. C.

Roentgen Examination: Shows large shadow indicating a granuloma at root of lateral incisor. Note the radiopaque substance in its center.

Operative Findings: Apicoectomy was performed. The bone cavity, as outlined in the picture, with outer wall perforated, contained partly necrosed granulation tissue. The radiopaque substance was found to be a piece of gutta percha.

FIGURE 233.

FIGURE 234.

FIGURE 235.

FIGURE 236.

FIGURE 237.

FIGURE 238.

Illustrations of Complications Caused by Periapical Infection.

Figure 239.

Patient: Miss G.

Roentgen Examination: Shows dark area around roots of two mandibular central incisors. A porcelain filling, attached by means of a platinum pin in the right central incisor, must have caused pulp disease, from which the infection spread to the other central incisor.

Figure 240.

Patient: Miss C.

Roentgen Examination: Shows pulpless lateral incisor with root canal partly filled. A shadow indicates that periapical infection has spread to the central incisor, which was entirely normal before. The pulp in the central incisor was found to be infected.

Figure 241.

Patient: Mr. T. A. J.

History: Had had swelling on side of mandible for two days previous to examination, but no pain.

Roentgen Examination: Shows extensive absorption of root apex of the first bicuspid. A dark shadow indicates loss of bone, due to infection, which spread to the cuspid and second bicuspid, involving their entire apices.

Figures 242 *and* 243.

Patient: Mr. W. D.

Roentgen Examination: Shows large shadows around the first molars on either side. The infection had caused absorption of the entire alveolar process and part of the inner cancellous bone of the body of the mandible.

Figure 244.

Patient: Mr. F.

History: Left mandibular second bicuspid had been extracted sometime previous to the examination, but pus continued to discharge through its socket.

Roentgen Examination: The Roentgen picture discloses the fact that infection has involved the first bicuspid. The shadow around its apex is seen to communicate with the place where the second bicuspid was removed.

Figure 245.

Patient: Mrs. N.

History: Lateral incisor had been extracted and replaced by a bridge four months previous to examination. A boil had formed near the wing of the nose.

Roentgen Examination: Shows dark area between the apex of the cuspid and central incisor. When opened up this was found to be filled with inflammatory granulation tissue and some pus. Apparently this was the granuloma which remained after extraction of the tooth.

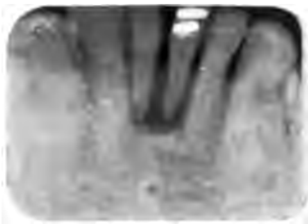


FIGURE 239.

FIGURE 240.

FIGURE 241.

FIGURE 242.

FIGURE 243.

FIGURE 244.

FIGURE 245.

Illustrations of Root Absorption and Exostosis.

Figure 246.

Patient: Mr. L.

Roentgen Examination: Shows a dark shadow indicating periapical infection on both the cuspid and lateral incisor. In both teeth resorption is clearly indicated by the irregular outline of the tooth surface.

Figure 247.

Patient: Dr. C.

Roentgen Examination: Shows shadow around cuspid and large area including central and lateral incisor roots. There is slight absorption at the apex of the lateral incisor, the central root showing extreme resorption.

Figure 248.

Patient: Mr. W. J.

Roentgen Examination: Shows well-defined dark area around the first and second bicuspids, the infection having caused absorption at the apices of both the roots.

Figure 249.

Roentgen Examination: Shows evidence of periapical infection, with absorption of the palatal root of the maxillary first molar.

Figure 250.

Roentgen Examination: Shows absorption of a large part of the apex of the lateral incisor.

Figure 251.

Roentgen Examination: Shows mandibular first molar, root-canal filling and dark shadows indicating periapical infection. Both roots show hypercementosis at each side near the apex.

Figure 252.

Roentgen Examination: Shows periapical infection on both roots of the mandibular first molar. Note the mesio-distal enlargement of the mesial root.

FIGURE 246.

FIGURE 247.

FIGURE 248.

FIGURE 249.

FIGURE 250.

FIGURE 251.

FIGURE 252.

Illustrations of Condensing Ostitis due to Periapical Infection.

FIGURE 253.

Patient: Mr. E. H. T.

History: Soreness of gum over root of right maxillary first bicuspid and formation of a fistula, which discharged a slight amount of pus.

Roentgen Examination: Shows dark shadow (with evidence of new bone formation in the superior part), indicating periapical infection with condensing ostitis.

Figure 254.

Patient: Mr. C. F.

History: Several years previous to examination he had an acute abscess on the mandibular second bicuspid. The tooth was treated and filled.

Roentgen Examination: Shows incomplete root-canal filling and a dark shadow surrounding the root of the tooth. Around this shadow is a light area, indicating abnormally radiopaque bone, due to condensing ostitis.

Figure 255.

Patient: Mr. W.

History: Had a very severe attack of acute abscess on the mandibular first molar many years ago.

Roentgen Examination: Shows root canals partly filled and a large area of bone of very radiopaque character. The dark shadow near the apex indicates that chronic inflammation persists.

Figure 256.

Patient: Mrs. I. O. H.

History: Patient said she had had periostitis thirty years before. A piece of necrosed bone was removed by her dentist. At time of examination the first molar was firm and reacted to the heat test.

Roentgen Examination: Shows one root very much shortened. An irregular area of light appearance shows eburnated bone. There is also a dark area at the distal side of the tooth surface under the filling, where decay has occurred.

Figure 257.

Patient: Patient, aged twenty-eight years. (Courtesy of Dr. F. A. Webb, Jr.)

History: Recalled that the left mandibular first molar had been treated ten or twelve years before. She stated that the tooth had never had an abscess (acute abscess).

Roentgen Examination: Shows mandibular first molar with evidence of root-canal filling. Condition about mesial root normal. Distal root shows evidence of extensive absorption. A dark shadow near the absorbed root-end indicates infection, while the extensive light area reaching as far down as the mandibular canal indicates condensing ostitis.

FIGURE 253.

FIGURE 254.

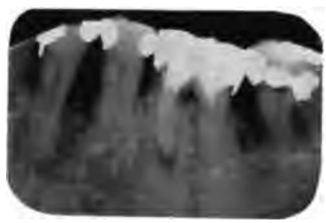


FIGURE 255.

FIGURE 256.

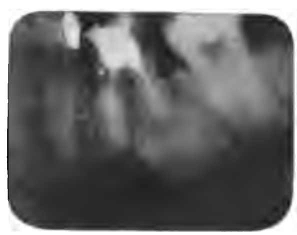


FIGURE 257.

Illustrations of Bone Repair after Periapical Infections.

Figure 258.

Patient: Mrs. M.

Roentgen Examination: The area over the right maxillary first bicuspid shows filling-in of the bone cavity with trabeculæ of bone. This picture was taken six weeks after an apicoectomy had been performed.

Figures 259, 260 *and* 261.

Patient: Mrs. L. C. R.

Roentgen Examination: Figure 259 shows large dark area around apex of lateral incisor. Figure 260 was taken when the treatment was finished and the root canal refilled. Figure 261 shows complete repair.

Figures 262 *and* 263.

Patient: Mrs. A. McE.

History: Had acute abscess on right mandibular central incisor. The tooth was somewhat loose. The root canal had been ionized and filled (Figure 390) and the operation was performed immediately.

Operative Findings: An apicoectomy was performed December 23, 1915. After the flap was lifted from the bone a great deal of pus escaped from the abscess cavity.

Roentgen Examination: Figure 262 shows the bone cavity immediately after the operation. Figure 263, taken in August, 1921, shows the same tooth and the bone condition after six years is normal.

FIGURE 258.

FIGURE 259.

FIGURE 260.

FIGURE 261.

FIGURE 262.

FIGURE 263.

IV. PERIODONTOCLASIA.

All pathological processes resulting in the diminution or destruction of the supporting and investing structures of the teeth have been classified by the American Academy of Periodontology under the heading Periodontoclasia. The following are some of the principal terms used:

Periodontology	Study of the tissues about the teeth.
Periodontia	The practice of correcting disturbances of the periodontium.
Periodontium	The pericementum and all investing structures of the teeth.
Gingiva	The mucous membrane surrounding the teeth and alveolar process.
Alveolar gingiva	The mucous membrane situated over the alveolar process.
Areolar gingiva	The loose mucous membrane situated beneath the alveolar process.
Gingival crevice	The space between the marginal gingiva and tooth cervix.
Alveolar crest	The triangular portion of the alveolus which terminates interproximally.
Normal occlusion	Innocuous distribution of stress exerted on the teeth during their use.
Traumatic occlusion	Abnormal distribution of stress exerted on the teeth during their use.
Ulatrophia	Wasting of the gingiva; confined to the marginal gingiva chiefly.
Periodontoclasia	Breaking down of the periodontium, also called periclasia.
Pericementoclasia	Breaking down of the periodontium and formation of pus pockets (formerly called pyorrhea alveolaris).
Alveoloclasia	Alveolar bone absorption which produces looseness (mobility).

In the treatment of periodontoclasia it is essential to carefully diagnose the pathological condition of each tooth separately, because in every mouth there is more than one form of periodontal disease present, and each tooth affected presents a different condition. Discovery of the extent of the disease is important in order to determine whether a tooth can be successfully treated. All pulpless teeth must be discovered and the condition of the periapical tissue ascertained, as a tooth which has both a periapical infection and some degree of periclasia is unfavorable for conservative treatment. From all this it is evident that a complete examination by the Roentgen method is an important step and absolutely necessary to make a perfect diagnosis.

Pericementoclasia.—In periclasia, disintegration of the peridental membrane occurs. This is generally associated with an absorption of the bone of the alveolar process, called alveoloclasia.

Alveoloclasia may be recognized in Roentgen pictures which, therefore, are of value to determine the extent and depth of the dissolution of the alveolar process. Some of the primary etiological factors may also be evident in the roentgenogram. Of these the most important are:

Malocclusion, especially mesio-distal malpositions and drifting resulting from extraction; also abnormal tooth forms and eruption (Figure 269 to 271).

Restorative defects such as faulty crowns and bridges with overhangs, cement forced into the gingival crevice, faulty fillings and inlays with projections of the cervical margins, cavities under the cervical part of the filling (Figures 272 to 275), or lack of proper proximal contact (Figures 276 and 277).

Unsanitary concretions, such as salivary, or serumal, calculi can be seen on account of their radiopacity (Figures 278 to 280).

Foreign bodies, such as filling materials, rubber dam, wire ligature, etc., causing trauma.

The Roentgen evidence of alveoloclasia is due to the dissolution of bone and replacement by radiolucent pathological tissue. In normal conditions a well-defined white line is visible, due to the lamina dura

of the alveolar socket and the cortical lining of the alveolar crest. The peridental membrane appears as a dark line between the lamina dura and the root of the tooth (Figure 281). When the bone becomes affected we see at first a diffuse, irregular outline of the surface of the bone (Figure 281 to 283). Sometimes in the early stages, when the wall of the alveolar socket has just become affected, a delicate, partial decalcification of the lamina dura is noticeable, extending along the alveolus and showing a wider space between the tooth and the bone. More and more of the bone becomes absorbed, the process being more rapid on teeth which, on account of malocclusion or unequal occlusion, receive a great deal of movement in mastication, and a triangular pocket appears at the side of the root in the roentgenogram (Figures 284 and 285). On other teeth we may find all of the alveolar socket around the entire tooth destroyed, forming a funnel-shaped pocket around the root (Figure 286). In molars, the septa between the roots are also often affected.

A roentgenogram reveals, principally, pockets at the mesial and distal sides of the teeth only, and while these may be extremely deep, there may be sufficient bone lingually and buccally to support the teeth, so that they remain very firm. On the other hand large pockets may exist at the labial and lingual surfaces, when the Roentgen picture shows normal bone at the mesial and distal sides. When the infection reaches the apex of the tooth, an acute periapical abscess may form, and pulpitis may set in. Under these circumstances the Roentgen appearance is the same as that described in the section on Periapical Infection (Figure 288 to 290).

The Roentgen method also affords, if pictures are taken at regular intervals, an excellent means of studying the continuous destructive process of alveoloclasia, as well as the progress of regeneration from treatment.

Parietal Abscess.—Periodontal abscesses which form in the peridental tissue other than at the pulpal foramina are called parietal abscesses. These are frequently found between the roots of multirooted teeth, but may also occur at the side of a tooth and are sometimes extremely difficult to recognize in a Roentgen picture, especially

if they occur at the labial, buccal or lingual surfaces of the tooth roots (lateral abscesses), or between the roots of a maxillary molar (interradicular parietal abscesses. Large granulomata are sometimes formed and may be the cause of severe neuralgia. The Roentgen method is, however, of great advantage in making a differential diagnosis, as it is very important to know whether we have to treat a periodontal abscess due to pulp infection or a parietal abscess, which may occur on a tooth with a perfectly normal pulp (Figures 291 to 293).

Gingival Infections and Abscesses.—These are often due to injury and trauma of the gingiva, but are also frequently associated with partly erupted, impacted teeth. Such teeth, although they pierce the gum with their cusps, never erupt entirely, and as the tissue is not attached to the enamel of the crown, a pocket forms, into which food and bacteria may enter at any time. When an infection sets in, an abscess is often formed in the gingiva, and later may even affect the bone, so that it becomes evident in a Roentgen picture. (See section on Unerupted and Impacted Teeth, Figures 118 and 125.)

Illustrations of Periodontoclasia in Dry Specimens.

Figure 264.

Specimen: Skull showing destruction of the marginal part of the alveolar process about a maxillary first bicuspid, malocclusion probably being the primary etiological factor.

Figure 265.

Roentgen Examination: Shows a similar condition, but caused by an ill-fitting gold crown. Note the dark areas on the mesial and distal sides of the first bicuspid, indicating alveoloclasia.

Figure 266.

Specimen: Shows alveoloclasia affecting the marginal part of the alveolar process. The roots of the teeth show calcarious deposits.

Figure 267.

Specimen: Dry skull.

Photograph: Shows alveoloclasia in later stage. Note condition around the maxillary second bicuspid, which is in faulty occlusion.

Figure 268.

Specimen: Photograph of a skull showing a still later stage of alveoloclasia. Deep pockets have formed. There is loss of the interdental septum between the mandibular cuspid and bicuspid and the first bicuspid and molar. The outer plate of the alveolar process has been destroyed completely about the maxillary central incisor, mandibular cuspid and first molar.

FIGURE 264.

FIGURE 265.

FIGURE 266.

FIGURE 267.

FIGURE 268.

Illustrations of Primary Etiological Factors in Periodontoclasia.

Figure 269.

Roentgen Examination: Indicates pocket at mesial side of maxillary second molar, due to malocclusion, mesial tipping, on account of loss of first molar.

Figure 270.

Roentgen Examination: Shows alveoloclasia due to malocclusion, reducing the entire process around the mandibular incisors. The teeth are drifting labially, as indicated by spaces on each side of the crown of the right lateral incisor.

Figure 271.

Roentgen Examination: Indicates pocket at distal side of mandibular cuspid, due to malocclusion and distal tipping of cuspid.

Figure 272.

Roentgen Examination: Shows deep pocket on mandibular central incisor, due to alveoloclasia, caused by restorative defect, a poorly fitting crown. The patient said the crown had caused irritation of the gingiva ever since it was put on.

Figure 273.

Roentgen Examination: Shows osteoclasia between second bicuspid and second molar, due to restorative defects. The film shows three etiological factors—overhang of the gold crown on the molar, tipping of the molar and surplus filling material between the crown and the bicuspid.

Figure 274.

Roentgen Examination: Shows alveoloclasia on distal side of bicuspid and molar, due to restorative defects, a loose filling pressed into the gingival crevice and cervical overhang of the inlay.

Figure 275.

Roentgen Examination: Shows alveoloclasia between cuspid and first bicuspid, due to restorative defect. The infection started from caries on the distal side of the neck of the cuspid, under a filling. Note also the pocket between the molars due to malocclusion.

FIGURE 269.

FIGURE 270.

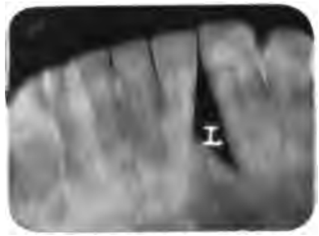


FIGURE 271.

FIGURE 272.

FIGURE 273.

FIGURE 274.

FIGURE 275.

Illustrations of Primary Etiological Factors in Periodontoclasia.

Figure 276.

Roentgen Examination: Shows loss of alveolar bone between all teeth, due to alveoloclasia. Note that the deepest pockets are found where there is a primary etiological cause, such as lack of contact between the molar and second bicuspid and between the first bicuspid and cuspid.

Figure 277.

Roentgen Examination: Shows loss of alveolar bone between all teeth. The pockets are very extensive. Those between the two bicuspids and two molars are caused by lack of contact, while the one between the second bicuspid and first molar is due to tipping of this tooth mesially.

Figure 278.

Roentgen Examination: Shows extensive alveoloclasia between all teeth. Note the serumal calculus at the sides of the roots.

Figure 279.

Roentgen Examination: Shows extensive alveoloclasia. Note the serumal calculus at the mesial side of the first molar root.

Figure 280.

Roentgen Examination: Shows alveoloclasia in the mandibular incisor region. Note appearance of salivary calculus at the necks and crowns of the teeth.

FIGURE 276.

FIGURE 277.

FIGURE 278.

FIGURE 279.

FIGURE 280.

Illustrations of Progressive Stages of Alveoloclasia.

Figure 281.

Roentgen Examination: Shows normal bone. Note lamina dura, a light line lining the alveolar sockets, and the peridental membrane which appears as a dark line around the roots.

Figures 282 *and* 283.

Roentgen Examination: Shows alveoloclasia in the bicuspid and molar region on both sides of the jaws. Note loss of interdental septa and spongy, irregular appearance of the outline of the remaining alveolar bone. In Figure 282 there is a deposit of serumal calculus on the mesial surface of the second molar. In Figure 283 the irregular outline and dark shadow on the distal surface of the first molar shows that the cementum of the root has been affected.

Figures 284 *and* 285.

Roentgen Examination: Shows more extensive alveoloclasia in the bicuspid and molar region on both sides of the mandible. Note the deep triangular pockets on the mesial side of the second molar in both cases. The first molars had been extracted and the second molars are tipping mesially.

Figure 286.

Roentgen Examination: Shows alveoloclasia. Note appearance of shadow around distal root of first molar. This indicates a funnel shaped pocket around the entire root.

Figure 287.

Roentgen Examination: Indicates that the anterior teeth of the mandible are entirely surrounded by radiolucent tissue, the pulps having become infected and been removed in two incisors. This is indicated by the small round white areas, which represent temporary fillings in the lingual surface of the crown, closing an opening made into the root canals. The Roentgen picture demonstrates how unreasonable it is to try to retain teeth which show resorption at the apex and are surrounded by diseased bone. This is a very extensive case of alveoloclasia.

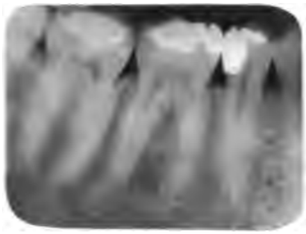


FIGURE 281.

FIGURE 282.

FIGURE 283.

FIGURE 284.

FIGURE 285.

FIGURE 286.

FIGURE 287.

Illustrations of Periodontal Abscesses due to Periodontoclasia.

Figure 288.

Patient: Mrs. H. E. D.

History: No symptoms of discomfort or pain. Patient said tooth was pulpless and treated.

Roentgen Examination: Shows dark shadow around entire root of left mandibular lateral incisor. Tooth shows evidence of root-canal filling and instrumental perforation at distal side. Diagnosis of alveoloclasia caused by perforation, combined with periapical infection of pulpal origin, was made.

Figure 289.

Patient: Mr. W.

History: Left mandibular molar very sensitive to percussion. Heat caused pain.

Roentgen Examination: Shows evidence of alveoloclasia on mesial side of tooth. The pocket extends to the apex of the fused roots, which are surrounded by a dark shadow. This, with the history, leads to the conclusion that we have here a periapical abscess, and pulp infection caused by periclasia.

Figure 290.

Patient: Mr. G. T. S.

History: Severe suppurating periodontoclasia. Fistula on gum of left mandibular first molar.

Roentgen Examination: Shows evidence of extensive alveoloclasia on all left mandibular teeth. A dark area, indicating a large abscess cavity, extends around the entire mesial root of the molar. This is a typical periodontal abscess caused by alveoloclasia.

Figures 291 *and* 292.

Roentgen Examination: Shows, in both cases, perietal abscesses between the roots of the mandibular molars. Note dark area between the roots, indicating bone absorption of the interradicular septum.

Figure 293.

Patient: Mr. A. I. E.

History: Had symptoms of acute abscess, with swelling of gum over right maxillary cuspid. His dentist started to open the pulp chamber, but found the tooth sensitive. Slight inflammation of the gingiva about all the teeth.

Roentgen Examination: Shows a dark area on the mesial side of the tooth, not extending entirely to the apex. A fine probe could be passed into this area from the gum margin, which, however, was very firm. This led to a diagnosis of lateral parietal abscess on a vital tooth. Note the small light area in the crown of the tooth, indicating the filling placed in the attempted opening to the pulp.

FIGURE 288.

FIGURE 289.

FIGURE 290.

FIGURE 291.

FIGURE 292.

FIGURE 293.

V. DISEASES OF THE MAXILLARY AND MANDIBULAR BONES.

Bone infections are generally not discovered for a long time after they begin, because they are usually chronic and not accompanied by any distinguishing symptoms. Pulpless teeth associated with them are, according to the histories of many cases, often treated for months by means of root-canal medication, without an accurate diagnosis, such as could have been made by the use of the Roentgen ray. The jaws, therefore, are frequently seriously involved when the patient finally consults a roentgenologist or oral surgeon. Every dentist should be familiar with various types of bone infection and with their clinical and Roentgen aspects.

Atrophy.—Decrease in the size of the jaws may be due either to a pathological or a physiological process. Tumors and cysts cause pathological atrophy, while loss of teeth is usually followed by absorption of the alveolar process. If all the teeth are lost in old age, the entire alveolar process disappears. This may bring the mandibula canal and the mental foramen close to the surface in the mandible, and in the maxilla sometimes there is only a thin wall of bone between the maxillary sinus and the mouth. These conditions can be recognized in a Roentgen picture (Figure 294).

Fractures.—Fractures occur more frequently in the mandible than in the maxilla because the maxillary bones are well protected by the zygomatic and nasal bones above, and by the mandible below. The Roentgen method is of great value in diagnosing the location and nature of a fracture. It indicates whether it is simple or multiple, and in comminuted fractures, where the bone is broken into small pieces and the teeth dislodged and driven into the wound, it helps in their localization.

In a Roentgen picture the fracture is recognized by a break in the continuity of the outline of the bone, and by displaced parts with dark lines or spaces between the fragments. After a fracture has been reduced, one can very often judge the result of setting the bones by the occlusion of the teeth, but it is always well to take a roentgeno-

gram and make sure that the best result possible has been accomplished. If healing of a compound fracture does not progress as expected, one should try to find out, by means of Roentgen pictures, whether sequestra or parts of teeth have been lost in the wound and overlooked.

Ostitis.—This is a bone infection of a more extensive type, usually developing from periapical infections. It may be suppurative, accompanied by violent, acute symptoms, but more often is chronic, developing from a chronic periapical infection. The latter type is called granulating ostitis. Suppurative ostitis is usually called acute alveolar abscess and has been described in the section on Acute Periapical Infection.

Granulating Ostitis.—Granulating ostitis may involve large portions of the jaw and several teeth without causing much pain or swelling. A fistula is seldom formed, and when it does occur is due to an exacerbation causing more active pus formation. The Roentgen picture in ostitis shows a dark area, usually of irregular outline, with very indistinct margins, due to a gradual change from healthy, calcified to diseased, inflammatory tissue, which is radiolucent.

Focal infections in the bone have been found by the writer in three cases. In all three the infection occurred in the anterior part of the mandible and was connected with the incisors, which were all normal otherwise, as were also the neighboring teeth. There was no history of accident or injury and the gums were healthy. Examination of the jaws showed no abnormality and there was no history of pain or swelling. The condition was discovered during routine Roentgen examination, while searching for foci of infection. Pathological examination of the tissue which was removed during the operation revealed it to be of inflammatory character, much like the tissue of a dental granuloma. All three patients were in very poor physical condition. One was tubercular, but the bacteriological examination of the tissue showed no evidence of tuberculosis. In these cases the disease must have been caused by hemolytic infection, as there was no other means of entrance possible (Figures 304 to 306).

Diffuse Osteomyelitis.—If we consider the frequency of dental infections involving the jaws, it is surprising how rarely we find a

case of diffuse osteomyelitis. The disease occurs most frequently in the mandible and spreads rapidly in the cancellous part, involving the whole bone and causing more or less necrosis. It is a serious disease and often a large number of sequestra are formed, with occasional subperiosteal abscess formations. The teeth in the affected part of the jaw are generally very loose so that pyorrhea is first thought of and then ruled out. Besides dental infections, specific infections, syphilis and tuberculosis may cause diffuse osteomyelitis (Figures 317 and 318).

The Roentgen ray at once establishes a correct diagnosis. In the early stage we find a rarefied condition of the cancellous part of the jaw (Figure 309). This is due to infection and enlargement of the marrow spaces between the trabeculæ of the bone. Later channels form, and in the roentgenogram the bone has the appearance of worm-eaten wood (Figures 310 and 311). In this stage bone necrosis sets in and sequestra may become separated from the rest of the bone. In one case which came under the writer's observation, spontaneous fracture occurred at the angle of the jaw before the patient received proper treatment. The Roentgen ray is useful both for making an early diagnosis and for locating loose sequestra, which, when entirely separated from the bone, have to be removed (Figure 312).

Necrosis of the Bone.—This is not a primary disease, but is rather the termination of a disease such as bone infection or periostitis. It can also be produced by poisonous chemicals, such as phosphorus or mercury, or anything which interferes with the nutrition; that is, the blood supply of the bone. A large portion of bone becomes cut off from metabolism and is then a dead substance which Nature tries to eliminate by exfoliation or absorption. It is separated from the vital tissue by the action of osteoclasts, and the separated dead part is called a sequestrum. Sequestra are obnoxious foreign bodies and cause continual irritation and suppuration. They are usually surrounded by inflammatory granulation tissue and the inflammation does not subside until they are removed.

Necrosed bone is recognized in Roentgen pictures by its irregular and indistinct outline. It is generally surrounded by a dark shadow,

caused by inflammatory granulation tissue around it (Figures 312, 315 and 316).

Cysts of the Jaws.—Cysts are of comparatively frequent occurrence both in the maxilla and mandible. They usually escape notice until they have attained large proportions and even then are not always recognized unless a Roentgen diagnosis is made. Some cysts cause changes in the visible surfaces of the jaws. These are generally more easily recognized than those inside the bone, or encroaching on the nasal cavity or maxillary sinus. Differential diagnosis is easier in the maxilla, where the characteristic parchment-like condition of the bone, producing a crackling sound on pressure, is much more frequently found than in the mandible. Here the massive cortical plates present considerable resistance to absorption and outward extension of the lesion.

Two types of bone cysts may be distinguished. One, originating from the dental follicle, is called a *follicular cyst;* the other, resulting from an infectious lesion, the so-called blind abscess or granuloma, is termed a *radicular cyst.*

Follicular Cysts.—Follicular cysts are caused by abnormal development of a tooth follicle during the developmental stage of the tooth.

Dentigerous Cysts.—Follicular cysts occur most frequently in connection with a misplaced, unerupted or supernumerary tooth. They may, however, be formed from the enamel organ without a tooth being developed. If the cyst contains a tooth it is called *dentigerous* (Figures 319 and 320). More than one tooth, either well-formed or rudimentary, may be found in a cyst.

Cystic Odontomata.—Instead of a perfect tooth being formed, sometimes only masses of calcified tooth particles are produced, and these may be composed of enamel, dentine, cement and dental pulp; also occasionally of bone. If a number of these different kinds of tissue are found, however, the lesion is called a *cystic odontoma* (Figures 321 and 322). Calcified tissue, however, is not always formed. A microscopic examination may show a mass, made up of an enamel organ with cylindrical epithelial cells and typical ameloblasts laying down enamel. This is called a *cystic adamantonoma.*

The cyst sac is usually composed of a fibrous membrane, lined by epithelium, which may be in a single layer, stratified or epidermoid in character. The bone immediately surrounding the cyst forms a compact compartment, such as we have seen exists around the tooth germ. No matter how large the cyst grows, this layer is continually absorbed and rebuilt. The liquid contained in the sac is clear and straw-colored, originating principally from a secretion by the epithelial cells. Cholesterin crystals are usually present and, if infection takes place, the liquid is contaminated by pus.

The Roentgen examination is of very great value, not only to locate the cyst, but also to give information as to the cause, extent and type of the lesion, and its relation to neighboring structures. Extraoral or large intraoral films should be taken, as small films seldom include more than part of the cyst. The cyst cavity, being radiolucent, produces a dark picture on the film, in which, however, may be seen Roentgen shadows of the calcified tissues contained therein. The cortical bone around the lesion is seen as a light line surrounding the cyst cavity. This is a characteristic of all Roentgen pictures of cysts.

Periodontal or Radicular Cysts. — These cysts etiologically are entirely different from the preceding class. They are of infectious origin, developing from a blind abscess or dental granuloma, which contains epithelial remnants from the enamel organ, such as are normally found in a dormant state in the peridental membrane of some teeth. Stimulated by chronic inflammation the epithelium is caused to proliferate, and epithelial chains grow like a network through the lesion. Having a tendency to grow between vital and necrosed tissue, the epithelium soon forms an entire lining of the abscess cavity. Accumulation of broken-down tissue and exudates causes extension of the cyst. It often grows to tremendous size at the expense of the bone, which disappears through pressure absorption. A cortical layer is formed around the bone cavity, in the same manner as that described under "Follicular Cysts." Sometimes the bone becomes so thin that a crackling sound can easily be heard on palpation.

The cyst sac usually has a simple epithelial lining, the underlying structure consisting of inflammatory granulation tissue of very fibrous

composition, containing large numbers of lymphocytes and plasma cells and, nearly always, cholesterin crystals. The fluid usually looks like pus. Detached cholesterin crystals give it a characteristic appearance, the color varying according to the type of contamination. Just how long cysts remain unnoticed depends a great deal on their location and rapidity of growth, and upon accidental changes in the pathological development. Symptoms may appear as changes in the facial contour, such as swellings on the cheek or side of the mandible, on the hard palate or under the lip. Distention of the cyst is often evidenced by indefinable pressure and occasionally causes displacement of some of the teeth. Pain is extremely rare, but in two cases I have seen complete paresthesia of the lower lip, due to involvement of the inferior alveolar nerve. A cyst with an opening into the mouth is noticed by the discharge of its excretion, which causes a bad taste and a disagreeable odor in the mouth. Secondary infection may occur through the diseased pulp canal or pus pocket of an adjacent tooth, and when subsiding, leave a fistula on the gum, which often leads to faulty treatment.

Roentgen examination, as for follicular cysts, should be made on large films or plates, as the small ones seldom cover more than part of the lesion. The cyst cavity appears as a black shadow on the negative. The cortical bone immediately surrounding the cavity, however, produces a characteristic light, but distinct, line, well-illustrated in Figures 327 and 328. The Roentgen picture also helps in making a differential diagnosis, and gives exact information regarding the size, shape and location of the lesion. Cysts may be found in the ramus or the maxillary sinuses (Figure 353). A picture also shows the relation to important neighboring structures, such as the inferior alveolar nerve, ascertains the number of teeth involved and their condition, and is a valuable guide for the operative technic.

Radicular cysts sometimes have no connection with a tooth root (Figures 333 to 335). In such cases the guilty tooth may have been extracted, the cyst having escaped notice at the time, or there may have been left in the jaw an epitheliated granuloma, which developed into a cyst later.

Multilocular Cysts.—Multilocular cysts may originate either from the formation of several cysts in one granuloma, from the formation of cysts on more than one tooth or in various medullary spaces of the cancellous part of the bone, the fluid accumulating and extending them, leaving bone lamellæ in between (Figure 336).

Tumors.—For tumors the roentgenogram is only of value in cases which produce bone, or in which bone substance is affected and degenerated, though it is also helpful in differentiating the latter from the more superficial varieties in order to determine the mode of operation.

Osteoma.—These are benign tumors and of very slow growth. They are frequently found in the jaw, especially on the lingual surface of the mandible and the palatal surface of the maxilla. The tumor usually consists of very dense cortical bone and is, therefore, extremely radiopaque, showing as a very light, well-defined area in the Roentgen picture.

Osteosarcoma.—Osteosarcomata are the most frequent tumors of the bone. They grow in the bone from its connective-tissue cells, as well as from bone-forming cells. When they grow in the cancellous part, they distend and destroy the bone. This condition can be recognized in the roentgenogram and differentiated from the fibrosarcoma. When they grow from osteoblasts of the periosteum, the new trabeculæ of bone can be seen extending mostly at right angles to the surface.

Carcinoma.—This is a malignant, epithelial tumor which infiltrates and may give rise to metastasis. It has a tendency to invade the lymph spaces, growing into the lymph vessels and giving rise to metastasis along the paths of absorption. A carcinoma is of very destructive nature, respects no tissue and even destroys bone. It may produce fatty degeneration, due to impaired metabolism, and necrosis of the soft and hard tissues as the result of local interference with the circulation. These changes, when they affect the maxillary or mandibular bones can be easily distinguished in a roentgenogram.

The Healing of the Jaws after Bone Operations.—It is not only interesting and scientifically valuable to follow the healing of the bone after extensive operations, but it is sometimes of clinical import-

ance. In the case of osteomyelitis described on page 230, many small sequestra were located at different periods of the healing process. The knowledge of their exact location facilitated their removal greatly. In other extensive operations the Roentgen picture will show the success of the treatment by the filling-in of the lost part of the bone. Callus formation which takes place to protect the weakened bone offers considerable resistance to the Roentgen ray and, therefore, is easily discernible in the picture. The callus forms after two weeks and bony bridges can be seen within four to six weeks after the operation. Complete restoration is not discernible for six to eighteen months, according to the size of the area and the age of the patient.

Illustration of Atrophy of the Jaws.

Figure 294.

Patient: Miss E. O. B.

History: Patient suffered from trifacial neuralgia on left side, especially referred to mandible and lip.

Roentgen Examination: A sharp spur is seen in the incisor region, the alveolar process and part of the mandible having been atrophied.

Result of Operation: The pain was relieved by anesthetizing the left inferior alveolar nerve. Removal of the spur gave no relief. Neurectomy of the left inferior alveolar nerve relieved the neuralgia.

FIGURE 294.

Illustrations of Fractures of the Jaws.

Figure 295.

Patient: Miss L. D.

Roentgen Examination: Shows position of the fragments after fixation of the teeth. There was considerable loss of bone, and after reducing the fracture the only points of contact were at the inferior border of the mandible. After three days the patient felt something snap in the jaw. This was the ramus moving into the position shown in the illustration.

Figure 296.

Patient: Mrs. A. L.

History: Patient was in automobile accident July 9, 1920, when jaw was fractured. The teeth were wired and the wires removed after one month. There was still discharge of pus from a fistula in the face. The wound was washed and dressed every day until October 30. At that time the lip was numb and the fistula on the face continued to discharge pus.

Clinical Examination: Showed ununited fracture, both fragments freely movable.

Roentgen Examination: Shows simple fracture with bone infection of long standing in the region of the mandibular second bicuspid. This tooth had decay in the crown and probably an infected pulp, causing the persistence of the pus discharge.

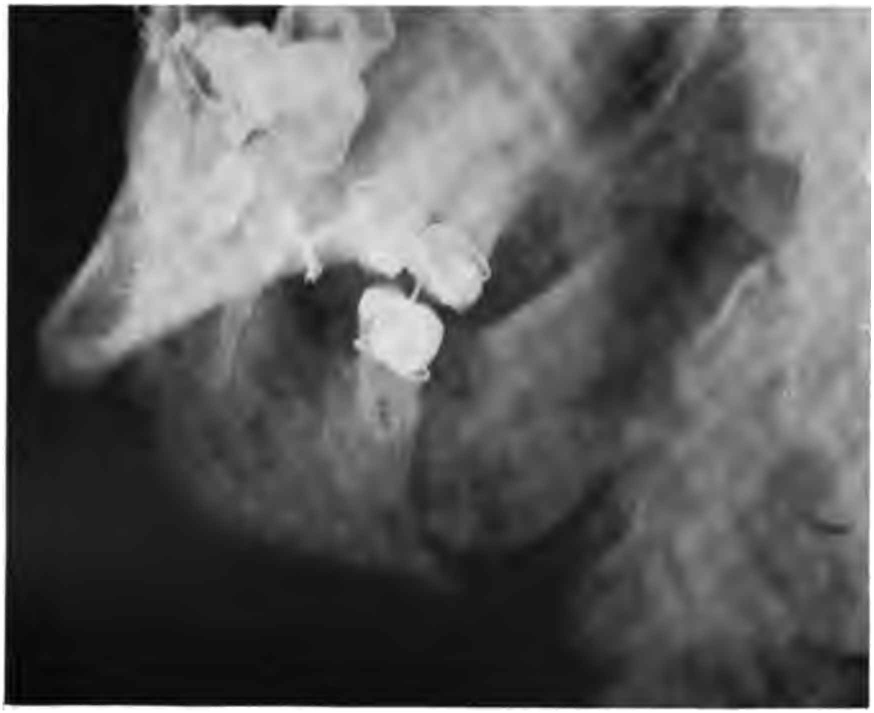


FIGURE 295.

FIGURE 296.

Illustrations of Fractures of the Jaws.

Figure 297.

Patient: Mr. G. O.

History: Patient had fallen while doing an acrobatic stunt three weeks previous and had broken leg and jaw. A splint which was attached to his teeth was removed by him before the fracture had healed.

Clinical Examination: Showed fistula on chin and ununited fracture at the symphysis.

Roentgen Examination: Shows a dark space between the cuspid and central incisor, extending down to the inferior border of the mandible. The socket of the lateral incisor, which has been lost, is also visible.

Diagnosis: Simple fracture with infection.

Figure 298.

Patient: Mr. R. C. P.

History: Patient fractured jaw eight weeks previous to the Roentgen examination. The teeth opened and closed fairly well, but the side movement was not so good, the forward movement being very poor.

Roentgen Examination: Shows fractured and displaced condyle.

FIGURE 297.

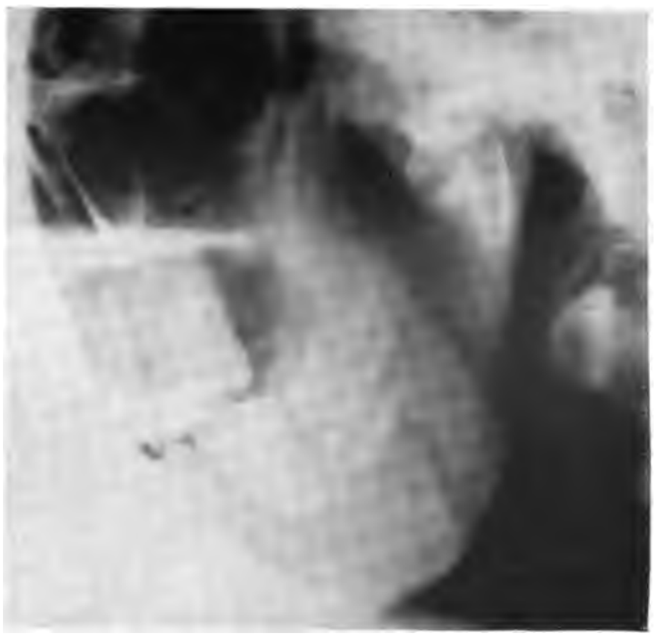


FIGURE 298.

Illustrations of Ostitis of the Jaws.

Figure 299.

Patient: Mrs. J. F. D.

Roentgen Examination: Shows dark area around root of left maxillary first bicuspid. There is no sharp demarcation of its outline. A diagnosis of granulating ostitis was made.

Figure 300.

Patient: Mr. G. L. S.

Roentgen Examination: Shows large dark shadow around roots of the second bicuspid and first and second molars. This indicates an extensive granulating ostitis.

Figure 301.

Patient: Mr. I. M. B.

History: Lateral incisor had been devitalized for long time. There was occasional discharge through a fistula, but no acute disturbance.

Roentgen Examination: Shows large area of irregular and indefinite outline and very dark appearance, the root apex being partly absorbed.

Operative Findings: The bone cavity was filled with granulation tissue, which was found to contain colonies of actinomyces.

Figure 302.

Patient: Mr. W. C. B.

Roentgen Examination: Shows large dark area with indefinite outline, into which protrudes the root of the lateral incisor.

Operative Findings: A large cavity filled with granulation tissue and pus was found, the surrounding bone being of spongy character.

Figure 303.

History: Left maxillary central incisor has been extracted and the root canal of the left lateral incisor had been treated.

Roentgen Examination: Shows extensive dark shadow, indicating granulating ostitis.

FIGURE 299.

FIGURE 300.

FIGURE 301.

FIGURE 302.

FIGURE 303.

Illustrations of Focal Bone Infections.

Figure 304.

Patient: Miss A. F.

History: Had nervous breakdown and considerable trouble with frontal sinuses. Previous to Roentgen examination of sinuses and teeth patient had no pain in teeth. Two weeks later patient returned with considerable swelling in the region of the mental fossa.

Roentgen Examination: Made on first visit showed a dark area around the roots of three mandibular incisors, which were otherwise perfectly normal.

Operative Findings: Showed granulation tissue and a little pus.

Figure 305.

Patient: Mr. S. A. B.

History: Patient had had tuberculosis fifteen years previous to examination. Had been very much better until within three weeks, when he had lost fifteen pounds. Teeth had always seemed to be entirely normal. No history of accident or injury.

Roentgen Examination: Shows dark shadow in the bone of the anterior part of the mandible, beneath and including the apices of the central incisors. There is no evidence of any cause for the condition.

Operative Findings: Large cavity in the bone, filled with granulation tissue. The pathological examination showed this tissue to be of infectious origin, but there was no evidence of tuberculosis.

Figure 306.

Patient: Miss Ada B.

History: Swelling and pain in chin and mandible. Teeth slightly loose. No history of accident or injury.

Roentgen Examination: Shows dark area beneath the apices of two mandibular central incisors, and extending way over the lateral incisors. No cause for the condition is evident.

Illustration of Osteomyelitis.

Figure 307.

Patient: Mrs. J. R.

History: The patient stated that the left mandibular second bicuspid had been broken off during an extraction. She had swelling and pain on the left side of the mandible for six weeks. Examination showed periostitis in the bicuspid and cuspid region on the outside. The broken-off root was removed and the abscess around its apex curetted. The pain, however, continued and the first bicuspid, cuspid and lateral incisor, which formerly had been slightly loose, became very tender on percussion. The swelling on the outside of the face and in the floor of the mouth increased. The three loosened teeth and one more on the other side were extracted, leaving the jaw edentulous. Drainage was established from the inside of the mouth, and a large abscess, which had formed in the floor of the mouth, discharged through this intraoral incision.

Roentgen Examination: Showed osteomyelitis of the mandible. Note the dark shadows in the body of the bone and the loss of bone at the inferior border. These spaces are filled in with inflammatory granulation tissue.

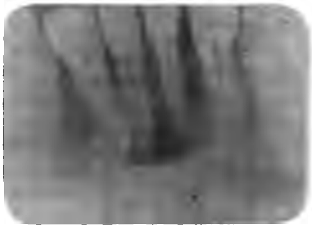


FIGURE 304.

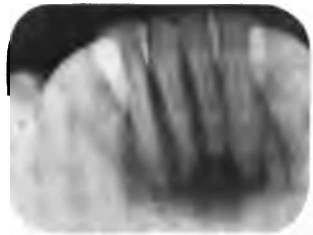


FIGURE 305.

FIGURE 306.

FIGURE 307.

Illustrations of Diffuse Osteomyelitis.

Figures 308–313.

Patient: Mrs. A. L.

History: Patient had a gold crown put on a tooth by her dentist on December 24, 1915. December 26, the tooth was extracted by another dentist, on account of an abscess condition. December 28, she went to a hospital and received palliative treatment. January 8, 1916, she was sent to the writer for examination. She complained of pain in the mandible, inability to open her mouth and soreness of the lower teeth. Temperature, 99.5° F.

Examination: In the mandible, the following teeth were present: a left molar and the bicuspids, cuspids and incisors on both sides. These teeth and both right bicuspids were extremely loose and there was evidence of the recent extraction of the right first molar. The maxillary teeth were firm and, apparently, in good condition. Wassermann test was negative.

Roentgen Examination: A dark area was found beneath the socket of the extracted right mandibular molar (Figure 308). From this place to the bicuspids on the other side, the entire body of the mandible showed a rarefied condition due to enlarged marrow spaces, indicating an osteomyelitic condition (Figures 308 and 309). The same condition was found in the alveolar process, the anterior part of which is shown in Figure 310.

FIGURE 308.

FIGURE 309.

Illustrations of Diffuse Osteomyelitis.

Patient: Mrs. A. L. (*continued*).

Operative Findings: On January 20, 1916, all the loose teeth in the mandible were extracted and the entire cancellous part between the cortical plates was curetted. Many small sequestra were found and removed. The wound healed rapidly, but two more pieces of bone were expelled later. March 2, the patient returned with swelling and pain on the left side. Another Wassermann test was negative and a new roentgenogram showed that healing had taken place on the right side, but that the process of disease had involved the left side extensively (Figure 311). An operation on this side was performed March 3 and from that time on the healing continued normally. September 8 two more sequestra became evident. One was removed from the mouth and the other from the submental region and the wounds healed by first intention. November 25 an abscess seemed to point at the angle of the jaw, where there was also considerable callus formation. The place was explored and a small sequestrum removed, but a fistula continued to discharge. A later roentgenogram (Figure 312) showed a normal condition everywhere except at the left angle of the jaw, where another small sequestrum was found in the middle of the bone. This was removed January 31, the fistula excised and the wound closed. The wound healed by first intention. The hard swelling disappeared gradually, so that the outline of the face was again normal.

FIGURE 310.

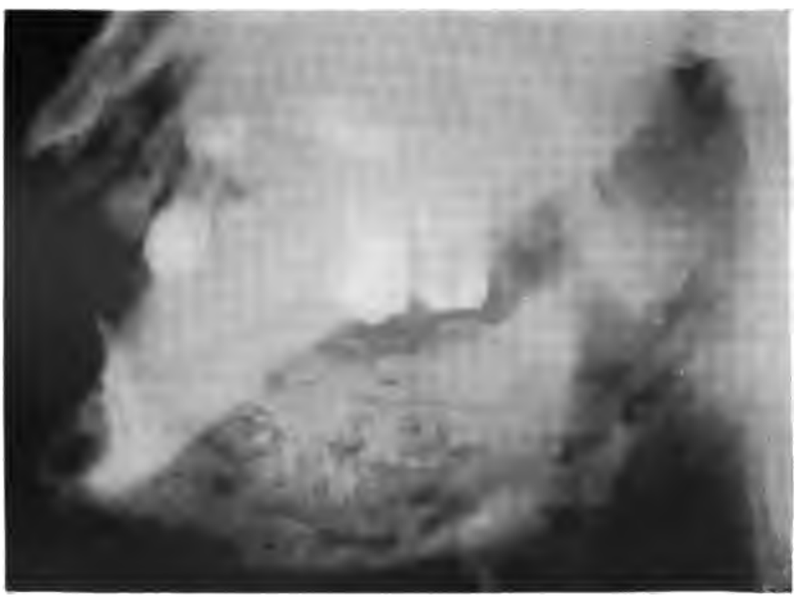


FIGURE 311.

Illustrations Showing the Process of Healing of Diffuse Osteomyelitis.

Patient: Mrs. A. L. (*continued*).

Roentgen Examination: Figure 312 shows a Roentgen picture taken eight months after the operation, when the bone was entirely normal except in one or two places. Note the mental foramen, which is radiolucent, and a small sequestrum which is radiopaque, surrounded by a dark area, due to inflammatory granulation tissue around the sequestrum.

Roentgen Examination: Figure 313 shows the other side, where complete healing has taken place after ten months.

FIGURE 312.

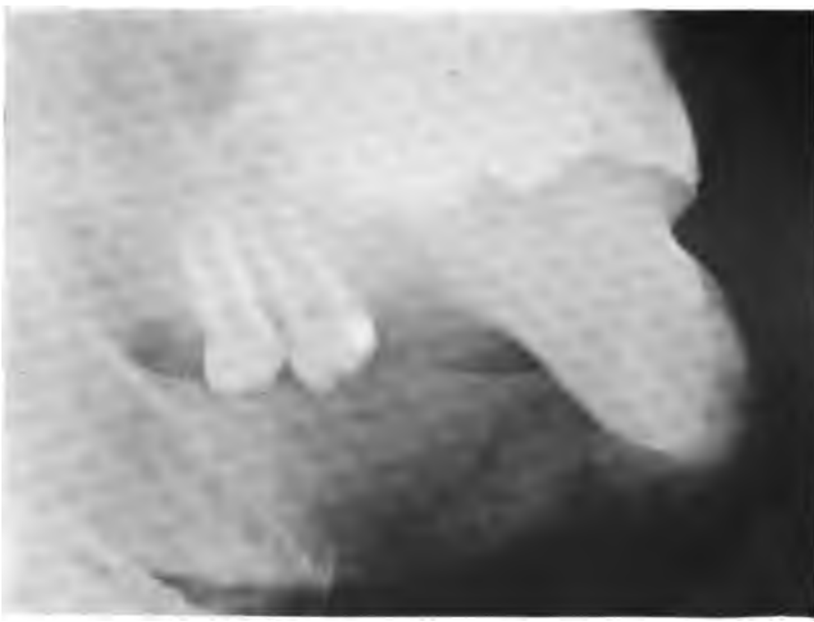


FIGURE 313.

Illustrations of Diffuse Osteomyelitis.

Figure 314.

Patient: Mrs. H. B. F.

History: Swelling on right side of maxilla. Condition had been treated from root canals of right maxillary central and lateral incisors and the gum had been lanced.

Roentgen Examination: Shows a rarefied condition of the entire region of the bone near the roots of this tooth. The very beginning of diffuse osteomyelitis, is shown in this Roentgen picture. A more definite type of the same stage is shown in Figure 309.

Figure 315.

Patient: Miss L. M., aged nineteen years.

History: Complained of mouth having felt sore for about eight months. Two teeth had been extracted and replaced by a bridge. The bridge was removed and the gum lanced without giving relief.

Roentgen Examination: Shows a large number of pieces of bone separated by dark shadows, which represent granulation tissue around detached bone. A diagnosis of osteomyelitis was made.

Operative Findings: One large sequestrum was found loose, and attached to it were the central incisor and first bicuspid; also some pieces of bone.

Figure 316.

Patient: Mr. S. A.

History: Patient had had pain on right side of jaw for several weeks. He had had several teeth treated and afterward extracted. There were very marked constitutional symptoms and the patient was in bed five days. When last seen by his dentist, extraction of the left mandibular third molar was advised. This was the only tooth remaining on that side. Examination showed swelling on the cheek and a fistula discharging pus into the mouth. The third molar was perfectly solid, but the incisors were tender on percussion. Temperature, 100° F. Pulse, good. No severe pain.

Roentgen Examination: Shows large pieces of bone separated by dark shadows, indicating extensive osteomyelitis of the mandible, with several sequestra.

FIGURE 314.

FIGURE 315.

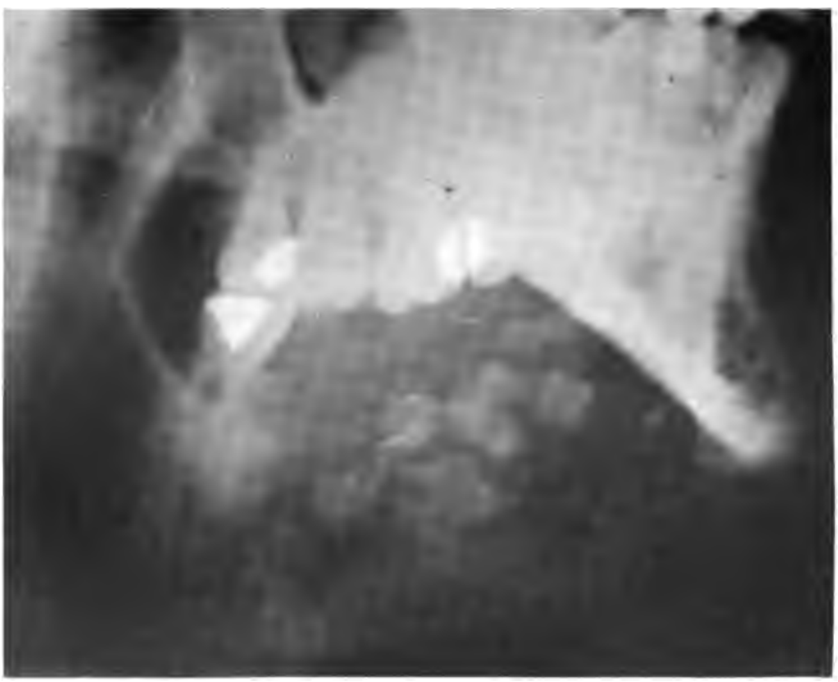


FIGURE 316.

Illustrations of Diffuse Osteomyelitis.

Figures 317 *and* 318.

Patient: Mr. W., aged about fifty-five years, married.

History: Said that he had been under treatment by a dentist in Boston for an abscessed mandibular left bicuspid. His physician examined him and advised having Roentgen pictures taken. Examination by the writer was made on February 20. Patient complained of severe pain in the jaw and neck and numbness in the region supplied by the left inferior alveolar nerve. The entire mandible was tender, especially in the submaxillary region; the submental region showed marked swelling; the gum over the bicuspid had been incised. Temperature was 99.2° F.

Diagnosis: From the examination and roentgenograms (Figure 317), the following diagnosis was made: Osteomyelitis of the mandible, especially the anterior region, as indicated by the many dark areas and channels through the body of the mandible. Almost all the teeth showed periapical infection.

Treatment: The teeth were extracted and drainage was established. The wound was irrigated several times a day. The condition, however, grew worse. On March 5 an abscess in the submental region was incised and three ounces of pus evacuated. The patient was greatly relieved and was dismissed from the hospital. The bacteriological examination showed the presence of Streptothrix anaërobicus. The soreness and pain continued, however, and Roentgen pictures taken at this time (Figure 318) showed osteomyelitis of the entire body of the mandible, with formation of sequestra. A Wassermann test made at this time was decidedly positive. The diagnosis of syphilitic osteomyelitis was at once followed by salvarsan treatment and resulted in speedy improvement. Roentgen pictures taken in July showed an almost normal condition, and the patient has since had no disturbance whatever.

FIGURE 317.

FIGURE 318.

Illustrations of Dentigerous Cysts.

Figure 319.

Patient: W. W., aged nine years.

History: Boy's mother noticed that he had a swelling on the left side of the maxilla in the cuspid region, about one year previous to consultation. She thought it was the cuspid about to erupt. There was no pain or soreness. A little later the deciduous first molar started to feel tender. It was filled, treated and refilled by a dentist, and finally fell out. A few weeks before examination by the writer a slight swelling was noticed on the left side of the face. Clinical examination revealed little beside the swelling on the face. The alveolar process showed no signs of a cyst.

Roentgen Examination: Revealed a large dentigerous cyst, containing an unerupted cuspid, apparently encroaching somewhat on the maxillary sinus and being located between the alveolar process, the nasal cavity and the palatal process. Note the light line around the cyst area. The foramen of the cuspid root is wide open. Roots of the deciduous cuspid resorbed.

Figure 320.

Patient: Mr. Si., aged about sixty-five years.

History: Patient complained of having a discharge with offensive odor in his mouth. Examination showed a fistula in the third molar region on the left side of the mandible. The second and third molars were missing. The second molar had been extracted a short time before, but this did not improve the complaint.

Roentgen Examination: Shows a dark area at the root of the first molar, but no impacted tooth. An extraoral picture, reproduced in Figure 320, shows a large dark area extending to the lower border of the mandible and almost to the angle of the ramus. The area is surrounded by a distinct light line, the typical picture of a cyst. The third molar is found near the angle of the jaw.

Diagnosis: Dentigerous cyst, infected from the mouth.

FIGURE 319.

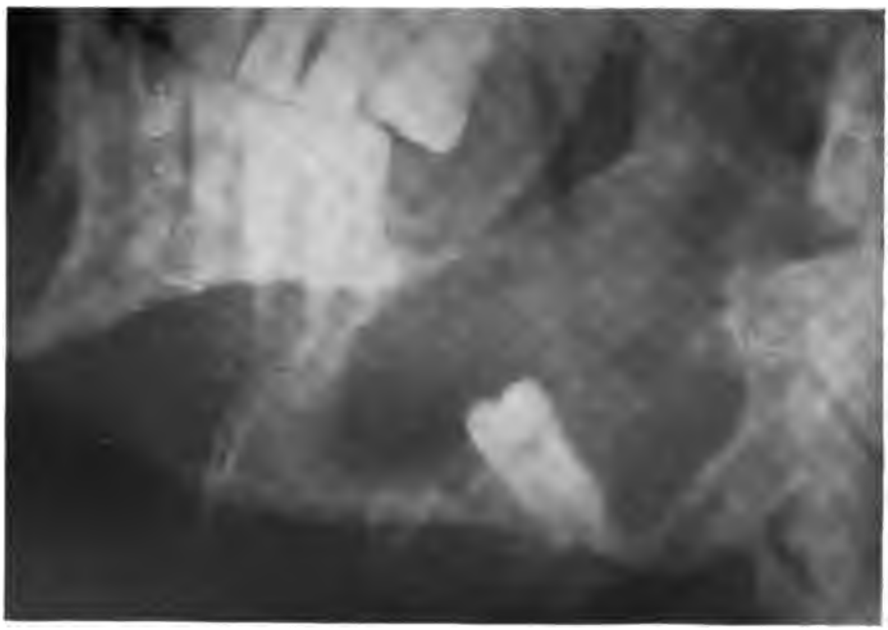


FIGURE 320.

Illustrations of Cystic Odontomata.

Figure 321.

Patient: Boy, aged fifteen years. (Courtesy of Dr. Halsy B. Loder.)

History: When first examined, patient had a swelling of the right side of the face. This was confined to the ascending ramus of the jaw. Gradual swelling had been noticed for nine months and was attributed to a blow. There had been slight pain.

Roentgen Examination: (Courtesy of Dr. Ariel W. George.) Shows a large dentigerous cyst, containing one well-formed tooth and a number of smaller foreign bodies of the same radiability as the tooth.

Operative Findings: After exposing the ascending ramus of the jaw, which was hardly thicker than an egg shell, the cyst was dissected free from the bone. The cyst, itself, was thin-walled in its upper part and nearly one-half inch thick in its lower part. In the course of the separation it was ruptured, and straw-colored fluid escaped. The cyst sac was removed, leaving a smooth-walled cavity in the bone.

Pathological Examination: Showed a cyst sac lined with epithelium and containing an odontoma (cystic odontoma).

Figure 322.

Patient: R. W., boy, aged sixteen years.

History: Patient noticed a swelling under his upper lip for several months, the left maxillary lateral and central incisors being somewhat tender to touch. His dentist opened the lateral incisor, removed the pulp and treated the root canal. Whenever the root-canal dressing was removed a yellowish fluid excaped from the tooth. The root-canal treatments failed to help the condition and the gum was lanced several times without result.

Roentgen Examination: When the boy was first seen by the writer a Roentgen picture was taken, from which a diagnosis of cystic odontoma was made. Note the dark area with definite outline, indicating a cyst cavity in the bone. The radiopaque substance in the center of the cyst is the odontoma.

Pathological Examination: Showed a fibrous membrane, infiltrated with leukocytes and plasma cells and lined with simple epithelium. In this was contained the odontoma, consisting of a mass of tooth germs and more or less well-formed rudimentary teeth; also a small amount of newly-formed bone.

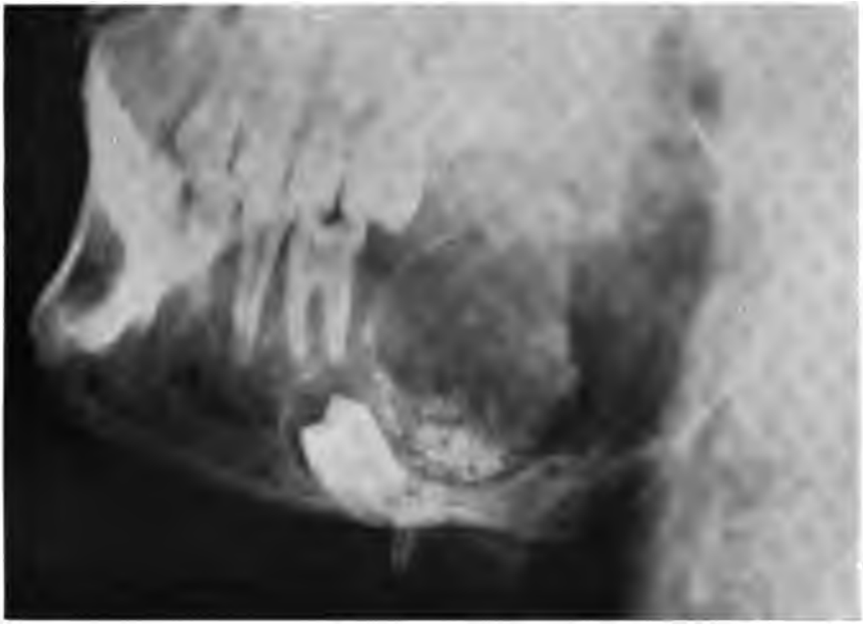


FIGURE 321.

FIGURE 322.

Illustrations of Periodontal or Radicular Cysts.

Figure 323.

Patient: Miss H. A. M.

Roentgen Examination: Shows dark shadow around root of second molar, the shadow being surrounded by a distinct light line. This is a typical picture of an incipient cyst. The floor of the antrum has been extended in a circular fashion by the expansion of the cyst.

Figure 324.

Patient: Mr. H. H.

History: Pus discharge from fistula on gum over right maxillary incisor. The central incisor had been extracted and a bridge constructed to replace the tooth.

Roentgen Examination: Revealed a cystic cavity, partly connected with the socket of the extracted tooth and the apex of the lateral incisor protruded into it. The tooth showed no signs of root-canal treatment. The picture shown in Figure 324 was taken after the root canal was filled. It shows the typical appearance of a small cyst, indicated by the dark area surrounded by a light line, which represents cortical bone surrounding the cyst.

Figure 325.

Patient: Mr. G. H. H.

History: Stated that three of the maxillary incisors were pulpless and had been treated seven years before. He had noticed a swelling for about seven months. He stated that an opening had appeared two weeks previous and a large amount of pus-like fluid had escaped.

Roentgen Examination: Shows a large radicular cyst, into which extend the apices of two maxillary incisors.

Figure 326.

Patient: Miss C. M.

History: Had an abscess "opened and scraped" eight years previous to examination. Condition was quiescent for some time, but after two or three years a fistula formed on the gum and there had been more or less pus discharge ever since.

Roentgen Examination: Shows typical picture of a large cyst extending into the hard palate, probably caused by the lateral incisor, which shows root-canal filling.

FIGURE 323.

FIGURE 324.

FIGURE 325.

FIGURE 326.

Illustrations of Periodontal or Radicular Cysts.

Figure 327.

Patient: Mr. M. E. H.

Roentgen Examination: Revealed a periodontal cyst involving three teeth, a central incisor with partial root-canal filling, a lateral incisor with good root-canal filling and a cuspid with no signs of root treatment. The latter tooth had probably become involved only recently, through lateral extension of the lesion.

The teeth were extracted and the cyst entirely removed, as in the previous cases.

Figure 328.

Patient: Mrs. C. E. B.

History: Complained of indefinable, dull pressure in the right side of the maxilla. At times she noticed discharge of pus on the gum, which for a time relieved the pressure. Several teeth had been extracted at different times, with only temporary relief. Examination showed a large swelling on the entire right side of the hard palate. A yellowish fluid was released when the alveolar process was punctured through the socket of one of the extracted teeth.

Roentgen Examination: Films and large frontal plates revealed an enormous cystic cavity in the palatal and alveolar processes of the maxilla, encroaching on the maxillary sinus to a considerable extent. The cyst was probably caused by the infected teeth, previously extracted.

Figure 329.

Patient: N. L., middle-aged man.

History: Patient stated that three weeks before his face had become swollen under the eye and on the side of the nose. There was no pain, but a great deal of inflammation, so that the eye was closed. A fistula had formed and was discharging pus below the inferior border of the orbit.

Roentgen Examination: Showed a large cavity in the maxilla, and a lateral plate taken at the same time revealed a bulging of the entire infraorbital surface of the maxilla. Three teeth were involved. A diagnosis of periodontal cyst with suppuration, due to secondary infection, was made. The operation exposed an extremely large cystic cavity extending to the nasal wall, the floor of the orbit and the maxillary sinus. There was, however, a bony wall separating it from the antrum.

FIGURE 327.

FIGURE 328.

FIGURE 329.

Illustrations of Periodontal or Radicular Cysts.

Figure 330.

Roentgen Examination: Shows a large area at apex of mandibular second bicuspid: filling in distal side of crown near pulp. Pulp probably infected. Well defined outline of shadow at apex leads to diagnosis of periodontal cyst.

Figure 331.

Patient: Mr. J. T. G.

History: Complained of a tender place on the outside of the face, especially noticeable when shaving.

Roentgen Examination: Showed a large cyst cavity, probably originating from an abscess on the right mandibular first bicuspid, both the neighboring teeth having become involved. A small, still darker area was seen immediately under the second bicuspid in the picture. The operation revealed a cyst cavity filled with pus and containing cholesterin. The cavity was lined by a membrane, which was covered with epithelium. The cyst was located between the two bone plates, in the outer one of which there was a perforation, showing in the Roentgen picture as the small dark area under the second bicuspid. This is the place where the patient felt the tenderness.

FIGURE 330.

FIGURE 331.

Illustrations of Periodontal Cysts.

Figure 332.

Patient: Mr. J. F. C.

History: He was unusually well until about a year before he was referred for examination of the mouth, when he broke down after a severe attack of grippe, the symptoms being principally those of a nervous collapse. He was in the South for two months and then returned to work. Had been examined at Johns Hopkins Hospital and was obliged to give up work again and spend about six months in the mountains. While there he had some dyspnea and was evidently very anemic. For some years he had suffered from hemorrhoids, and on August 17, 1916, was operated upon. Dr. Locke, who took care of him at this time obtained the following result from a blood examination: Hemoglobin, 85 per cent; leukocytes, 6000; red count, 5,300,000. On September 18, 1916, the blood count was as follows: Hemoglobin, 85 per cent; leukocytes, 7000; red count, 5,120,000. The patient at this time had recovered from the operation entirely, and seemed in much better health. The white count, however, had increased and the red count decreased.

Roentgen Examination: Showed a large periodontal cyst of the jaw and abscesses about the roots of two teeth. About sixteen years previously the patient had had an acute abscess on the left mandibular first molar, which had to be extracted. A little piece of the root of this tooth was left, apparently, and is seen in the middle of the cyst, which appears in the picture (Figure 332). The operation disclosed a bone cavity lined with the usual cyst sac and containing the apex of the first molar. Evidently the cyst had developed from the abscess, which had occurred years before. The result of the operation is shown by the following report of the blood count, October 11: Hemoglobin, 92 per cent.; red count, 5,500,000. The patient has been examined several times since the operation. He has been perfectly well ever since, and the condition of the mouth is perfect.

Figure 333.

Roentgen Examination: Of same patient, eight months later, shows filling-in of the cavity with bone.

FIGURE 332.

FIGURE 333.

Illustrations of Periodontal Cysts.

Figure 334.

Patient: Mrs. T. K.

History: Complained at various times of an inflammation of the gum under a bridge in the mandible. Her dentist had lanced the gum several times. On examination the bridge was found to extend from the second bicuspid to the third molar, and one of these teeth was suspected of causing the trouble. The gum around the bridge was hypertrophied, and pus could be pressed out from a fistula.

Roentgen Examination: Showed that the two bridge abutments were perfectly healthy teeth with normal pulps. A large cavity in the bone between the two teeth presented in the Roentgen picture the typical appearance of a cyst. A diagnosis of infected radicular cyst was made. Apparently the guilty tooth had been extracted years before, leaving a blind abscess, containing epithelium, or else the cyst was present at that time, but was not discovered during examination.

Figure 335.

Patient: Mr. C. H. H.

History: Had a tooth extracted on the right side of the mandible in the molar region. Examination showed a swelling and tenderness at the lower border of the mandible.

Roentgen Examination: Shows large shadow of characteristic cystic appearance in the body of the mandible. The cavity extends from the inferior border of the mandible to the alveolar ridge, and communication with a tooth socket at its anterior aspect is visible. During the operation the inferior alveolar nerve was found outside of the cyst membrane, but the bony canal had disappeared.

FIGURE 334.

FIGURE 335.

Illustrations of Periodontal Cysts.

Figure 336.

Patient: Miss E. R. (Courtesy of Dr. H. H. Germain.)

History: Patient had had swelling of the mandible (outer surface) for several months. The teeth had been treated without relieving the condition.

Roentgen Examination: (Courtesy of Dr. A. W. George.) In the bicuspid region of the mandible several dark shadows are seen, separated by lamellæ of bone. The second bicuspid appears to be a vital tooth. From its apex the most prominent vertical septum starts, and on each side of it there is a dark area, indicating a cystic compartment. These may have been caused by granulomata on the roots of the first bicuspid and first molar, which had previously been extracted. The cuspid is also pulpless and seems to extend into the cyst.

Figure 337.

Patient: Miss G. B. C.

History: Had suffered dull pain in mandible for seven years and at the time of examination had numbness in the left side of the lower lip and bad taste in the mouth. She had had several Roentgen pictures taken, but no cause was found.

Roentgen Examination: Showed a large cyst in the ramus. In the negative a characteristic white line is seen surrounding the lesion. A very dark area was revealed in the region of the post-molar triangle. After an incision was made over the post-molar triangle, a perforation of the bone was revealed, which appears in the Roentgen picture as a very dark area, about the size of a pea. The bone over the post-molar triangle was cut away and a large cyst cavity, involving the ramus from the sigmoid notch to the lower border, was exposed. The cyst sac communicated with the socket of the third molar and contained a great deal of pus and cholesterin. The patient was again seen after three years and a new Roentgen picture showed complete healing. The symptoms had entirely disappeared.

FIGURE 336.

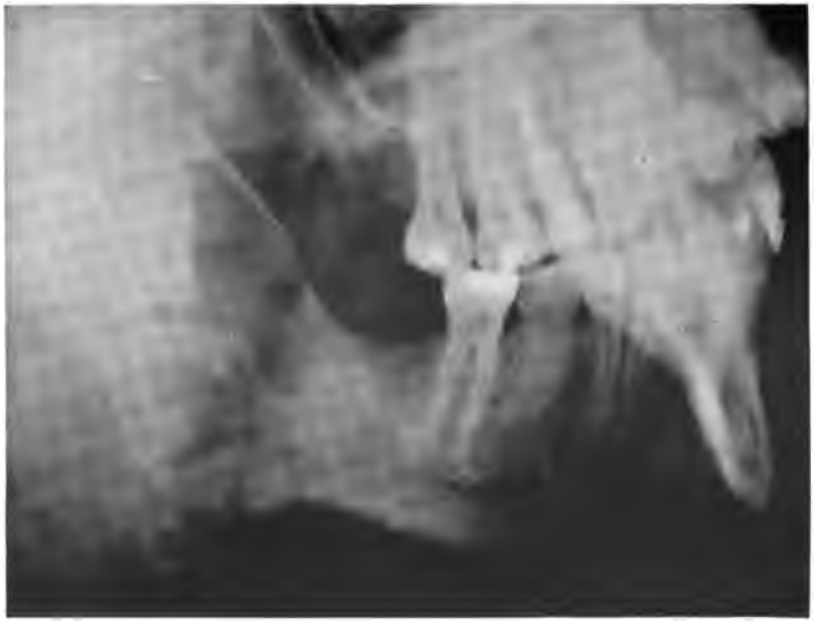


FIGURE 337.

Illustrations of a Multilocular Cyst.

Figures 338 *and* 339.

Patient: Mr. R. W., aged nineteen years.

History: (Courtesy of Dr. Samuel Mixter and Dr. G. D. Cutler.) When one year old the patient received a hard blow on jaw and was supposed to have a fractured jaw. Since that time, a slow, continuous, painless growth went on, but the tumor had been the same size ever since the patient could remember. About five weeks previous to the last examination he had received an injury caused by a piece of ice striking his chin. One week later he had some pain and an abscess formed, which broke and discharged pus and some blood, the discharge continuing through the fistula until the present examination.

Examination: Well-developed young man. Large, hard, irregular tumor on mandible, mostly on right side, so firmly attached that it was continuous with the bone of the mandible. Skin of tumor not adherent, abnormal nor tender, except at right corner of the mouth, which was the site of the abscess.

Roentgen Examination: Roentgen plate (courtesy of Dr. L. B. Morrison). The pictures shown in Figures 338 and 339 were taken from different angles. Note the large cystic cavities and their relation to the decayed teeth.

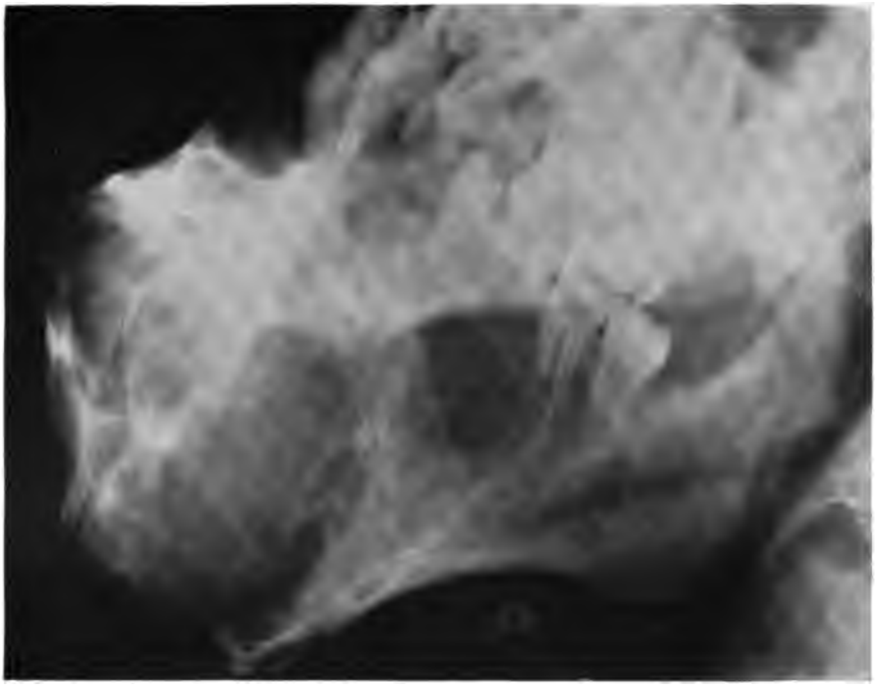


FIGURE 338.

FIGURE 339.

Illustrations of Carcinomata of the Jaws.

Figure 340.

History: (Courtesy of Dr. L. B. Morrison.) The tumor started as an epithelioma of the lip. The metastatic processes of the carcinoma affected the mandible.

Roentgen Examination: Shows destruction of a large part of the mandible. Note the increase in radiability of the part where the bone has been destroyed by the tumor.

Figure 341.

Patient: Mr. M. C. J., aged sixty-six years.

History: Had been well all his life, except for childhood diseases. His nephew had died of cancer of the jaw two years before. Five or six months ago patient found that he had five or six loose teeth on the left side of the mandible and he had them extracted by a dentist. A few weeks later he extracted three more teeth himself. He stated that when he first went to his dentist the jaw was somewhat swollen, but after the extraction it was a little better.

Clinical Examination: Revealed a large tumor in the mandible, extending from the ramus to the incisor region. All the teeth on that side has been extracted. The surface of the tumor was irregular and extended well into the side of the tongue. One or two glands in the neck were enlarged.

Roentgen Examination: Shows extensive destruction of bone in the place taken up by the tumor, extending from the region of the cuspid to the ascending ramus. The bone absorption was shown to have reached within almost a third of an inch of the inferior border of the mandible. The inferior dental canal is still visible in the posterior part of the mandible.

Pathological Examination: Carcinoma.

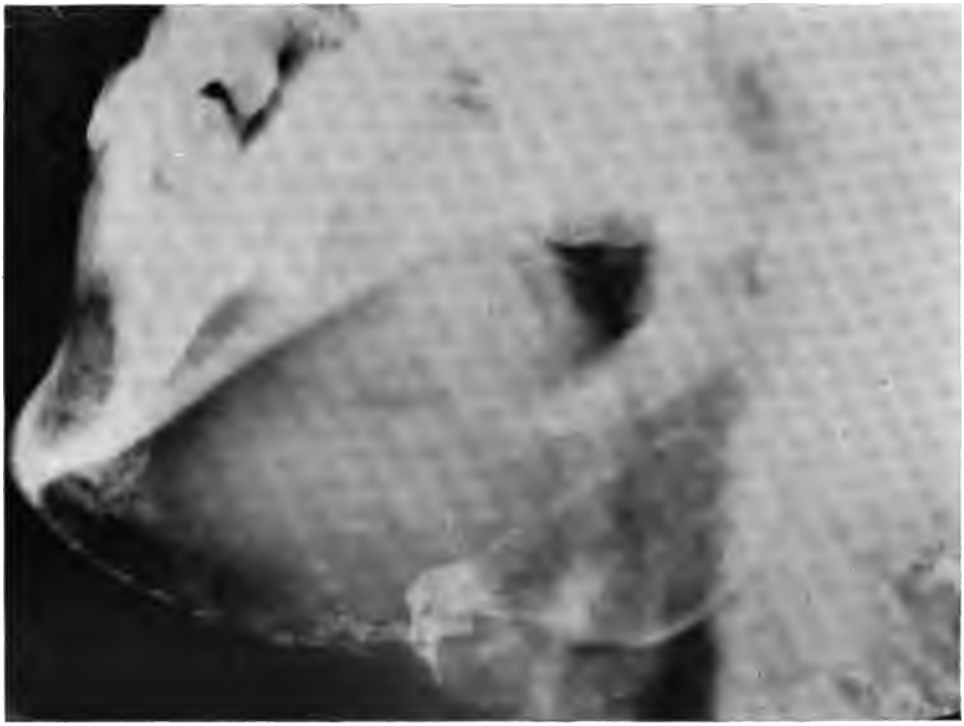


Figure 340.

Figure 341.

VI. DISEASES OF THE ACCESSORY SINUSES OF THE NOSE.

The accessory sinuses of the nose have already been studied, as to their Roentgen appearance when normal. Since dental infections are among the most frequent causes of infection of the maxillary sinuses, special consideration will be given here to the pathology of these sinuses. The frontal, ethmoid and sphenoid sinuses, however, are also frequently involved and the oral roentgenologist should be familiar with their appearance in the Roentgen picture when diseased.

While Roentgen examination is of undoubted value in cases of sinus disease, it should not be solely relied upon, but should be considered in conjunction with clinical examination before a diagnosis is made. The Roentgen picture is important for differentiation between normal and diseased conditions as well as for the surgeon to determine the size and shape of the sinuses, the presence of partitions and their relation to each other. It is a helpful guide during the operation.

Infection of the Accessory Nasal Sinuses.—In studying the difference in appearance between the normal sinus and one which has been changed by an inflammatory process, the beginner should remember, first of all, that the normal sinus, being a space filled with air, is radiolucent and, therefore, appears as a dark shadow on the negative. Any pathological changes which cause increase in the size of the membrane of the sinus, or obliteration of the air space with tissue or fluids, decreases its radiability, so that these pathological changes result in a lighter tone of the area representing the sinus. This appearance of the sinuses in the picture is spoken of as cloudiness. When the sinus is cloudy it also causes the well-defined marginal line to disappear. This is especially true of the frontal sinuses. The radiability of a sinus is judged by comparison, for example, of a suspected maxillary sinus on one side with a normal one on the other. If both sides are diseased we find that the orbit furnishes a means of comparison. Its shadow is normally about the same as that of the sinuses.

It is difficult, if not impossible, to determine the degree or character of the inflammatory changes in the membrane, or to draw any exact conclusion as to the nature of its pathological content. It has been

demonstrated that water, normal saline, gelatin, mucous and pus decrease the radiability of a cavity normally filled with air. A sinus would, therefore, be radioparent whether it was filled with mucous or pus. The condition of the membrane itself, however, is also of the greatest importance. The inflammatory infiltration of the membrane of the sinus by serum and leukocytes, which sometimes causes a tremendous increase in its size, changes the radiability of the cavity as much as if it were filled with fluid. This can be easily demonstrated by taking a Roentgen picture of acute sinusitis when the cavity is filled with pus and another after it has been irrigated and drained. Theoretically, of course, there is a slight difference in the way in which these different conditions affect the radiability of the sinuses, but aside from variations in the penetrating quality of the rays and the effect of development, variations in depth and in the amount of fluid accumulated would still make enough difference to overthrow all other calculations. In a general way, however, one might say that in acute inflammation, especially if the sinus is entirely filled with secretions (whether mucous from nasal catarrh, or pus from an infection), the resulting picture will generally show a fogged appearance of even tone over the entire sinus. In chronic inflammation, particularly if the sinus is filled with masses of polypoid tissue, the appearance is more an uneven cloudiness.

When interpreting a sinus plate one should always be on the lookout for shadows cast by other parts of the head, as described in a previous section. It should also be remembered that an infiltration of the tissue of the face outside the sinus may decrease the radiability of the face to such an extent that the part of the picture including that sinus appears fogged, or cloudy. Such an infiltration may spread from an abscess on a maxillary tooth and the same condition may be caused by a cellulitis, or any other acute inflammation of this part. A similar reason for such a condition is sometimes found in women patients, when the hair is not evenly divided and a thick strand hangs over one side of the head. In doubtful cases a second exposure, from a different angle, should be made, and if it is a question of pathology of the maxillary sinuses, another picture, taken from Water's position will be of great value for purpose of comparison.

Infection of the Maxillary Sinuses of Dental Origin.—Maxillary sinusitis in its various forms is, according to Brophy, in about 75 per cent of the cases, due to diseases of the teeth. Acute infections may be caused by careless instrumentation, or pushing of an infected root into the sinus. Chronic abscesses on the maxillary teeth very frequently cause chronic infection of the antra, with polypoid degeneration of the mucous membrane. This condition often develops without the patient's knowledge, and is discovered only in routine examination. If extensive diseased areas are seen in the Roentgen pictures of the maxillary molars and bicuspids, as shown in Figure 346, sinus disease should always be considered as a possibility and Roentgen pictures of the head should be taken for investigation of the sinuses. On the other hand, in cases of sinus symptoms, or sinus disease, the teeth should not be neglected, and their condition must be investigated roentgenographically before any treatment is undertaken.

It should also be remembered in connection with a probable dental cause that a small shadow around a root does not necessarily mean that the dental condition is negligible, because in some cases there is not enough bone between the sinus cavity and the alveolar socket to become destroyed, and formation of a large abscess cavity is impossible. Such a condition is more liable to cause sinus infection (Figure 343) than a tooth with an extensive abscess cavity well removed from the floor of the sinus (Figure 344). This is well-illustrated in the writer's own case (Figures 348 to 350). The pulp of the tooth in question, a right maxillary bicuspid, was removed several years ago on account of an exposure made when preparing the tooth for a cohesive gold filling. About one year ago a roentgenogram (Figure 348) was taken, which showed a very slight periapical infection. The root canal was treated experimentally by various modern methods, and then filled under strict asepsis. Sometime later a bridge was attached to the tooth, which became slightly tender, and one morning a fulness and throbbing sensation was felt in the region of the right maxillary sinus when stepping hard. A small amount of gelatinous substance was discharged through the right nostril. An anterior-posterior Roentgen picture, taken the same day (Figure 349) showed the right sinus to

be cloudy and on transillumination it was entirely dark. The tooth was extracted at once and a probe passed into the alveolar socket, which showed, however, that there was no opening through the floor of the antrum. No further treatment was resorted to; the symptoms disappeared and, after seven weeks, the sinus was clear on transillumination and in the Roentgen picture (Figure 350). Another picture (Water's position) is shown in Figure 108. This was taken one year later and shows that the maxillary sinus remained normal. This also teaches us that it is not necessary for the dental infection to have direct communication with the sinus. The infection may spread through the Haversian canals of the bone.

Mucocele of the Frontal Sinuses.—This is a condition in which the sinus becomes distended; its natural outlet is obstructed and within the cavity there is an accumulation of mucoid secretion. The condition can be compared with a cyst, such as those connected with the teeth. The extension of the mucocele causes a thinning of the walls, so that the picture of a mucocele shows an external thin outer or facial walls as is well shown in Figure 352.

Dental Cysts Invading Maxillary Sinuses.—Periodontal cysts developing from the maxillary bicuspids or molars, or dentigerous cysts originating from misplaced tooth germs, often encroach upon the maxillary sinus. The writer has seen three cases of periodontal cysts of such large dimensions that they almost completely filled the sinus cavity. In all three cases there was a thin bony wall separating the remaining part of the nasal cavity from the cyst cavity. This can usually be seen in the Roentgen picture, unless the bone has become so thin that it is like parchment. The Roentgen picture shows radiopaque tissue in the lower part of the maxillary sinus. This is nearly always separated from the normal part (which remains radiolucent), by a clear, well-defined light line, usually a segment of a perfect circle (Figure 353). A side view generally shows its relation to the teeth, as well as the dimensions of the cyst in an anterior-posterior direction.

Cysts of Nasal Origin.—These are caused by the degenerating process of the membrane of the sinus and should be distinguished from

those of dental origin. They do not always start from the floor of the sinus (Figure 355).

Foreign Bodies in the Maxillary Sinuses.—The principal considerations are teeth and roots forced into the maxillary sinuses during attempted extraction. This is especially liable to happen when the root protrudes into the sinus to a considerable extent. Views from the front and side help in locating the foreign body, and a stereoscopic picture, of course, will do the same (Figure 345).

Malignant Disease of the Sinuses.—One of the most important aids in treatment of malignant disease of the sinuses is to determine how extensively the face and sinuses are involved, and both frontal and lateral views should be taken. The picture will show both the bone destruction and the obliteration of the air spaces by the radiopaque tissue of the lesion.

Roentgen Examination to Determine the Result of Treatment.—Roentgen examination after surgical treatment, or treatment by irrigation, will show the progress of repair. When the membrane again becomes normal, the cloudiness disappears and in time, usually about six weeks after completion of the treatment, the appearance of the diseased side becomes the same as that of the healthy side (Figure 350) unless permanent thickening of the membrane has taken place. It must be remembered also that after radical operations, the sinuses, especially the frontal ones, may be obliterated, which again changes the Roentgen picture entirely.

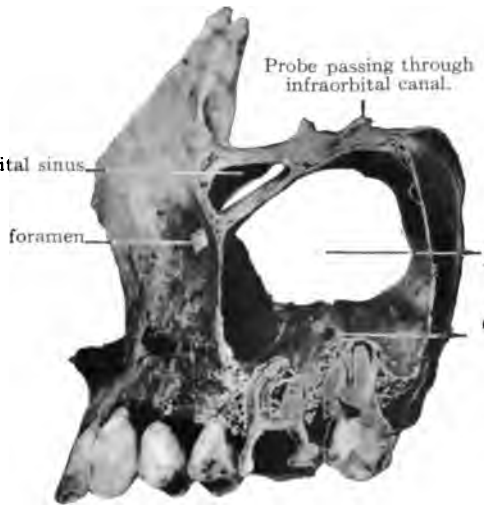


FIGURE 342.

Specimen: Section through maxillary sinus, showing opening of an abscess cavity on the root of a second molar within the floor of the sinus. (Cryer.)

Illustrations of Teeth which were Etiological Factors in Maxillary Sinusitis.

Figure 343.

Patient: Miss F. E. M.

History: Had been feeling very poorly for several months.

Roentgen Examination: Shows right maxillary third molar well. Both molars protrude into the maxillary sinus pulpless. A sinus plate showed cloudiness of the right maxillary sinus.

Figure 344.

Patient: Mrs. B. K.

History: Teeth had never given any pain nor inflammatory symptoms.

Roentgen Examination: Shows root canal filling in left maxillary second bicuspid; dark shadow around first bicuspid and cuspid. Compare this with the case illustrated in Figure 343. In Figure 344 a considerable thickness of bone is shown between the floor of the maxillary sinus and the tooth apices. The sinus in this case was normal.

Figure 345.

Patient: Mr. D.

History: While extracting the first molar, which was very brittle, the palatal root was pressed into the maxillary sinus.

Roentgen Examination: Shows its position and is an aid in its removal. The root is very indistinct, but its outline can be discerned immediately over its alveolar socket with apex directed mesially.

Figure 346.

Patient: Miss M. L.

History: Had been in a run-down condition for a considerable length of time. Had been under a physician's care, but did not improve.

Roentgen Examination: Shows indications of many pus pockets and abscesses in the right side of the maxilla. An anterior-posterior plate showed cloudiness of the maxillary sinuses.

Result of Operation: After removal of the teeth and treatment of the maxilla, which proved to be infected, the patient improved rapidly.

Figure 347.

Patient: Mrs. A. H.

Roentgen Examination: Shows a dark area around the roots of the maxillary first molar, which is fractured. Involvement of the maxillary sinuses was suspected and confirmed by a sinus plate.

FIGURE 343.

FIGURE 344.

FIGURE 345.

FIGURE 346.

FIGURE 347.

Illustrations of Maxillary Sinusitis from Dental Causes.

Figures 348, 349 *and* 350.

History: The pulp of the right maxillary second bicuspid had been removed several years previously on account of an exposure from instrumentation when preparing the tooth for a cohesive gold filling. One year before examination a roentgenogram showed a very slight shadow around its apex (Figure 348). The root canal was retreated at that time, by the best methods and filled under strict asepsis. A bridge, replacing the first molar, was attached to this tooth and the second molar. Some time later the bicuspid became sensitive to percussion and mastication, and one morning a fullness and throbbing sensation was felt in the region of the right side of the face, especially when stepping hard. A small amount of gelatinous substance was discharged from the right nostril.

First Roentgen Examination: Figure 348, taken the same day showed distinct cloudiness of the right maxillary sinus. On transillumination it was entirely dark.

Second Roentgen Examination: The tooth was extracted at once, and the condition promptly improved. All the symptoms disappeared and apparently the cause was removed in time. After seven weeks a second Roentgen picture was taken. This showed both maxillary sinuses to be of normal radiability (Figure 350). A picture taken one year later is shown in Figure 108.

FIGURE 348.

FIGURE 349.

FIGURE 350.

Illustration of Mucocele of Frontal Sinus.

Figures 351 *and* 352.

Patient: Mr. D. A. M. (Courtesy of Dr. George L. Tobey, Jr.)

History: Intermittent frontal headaches for five years. For two years had noticed slight prominence over left frontal region. No history of nasal discharge. During the six months previous to examination, left frontal pain had been very severe and almost continuous—tenderness, redness and swelling over left eye. Intermittent relief following occasional mucopurulent discharge from left nostril.

Examination: Evident prominence over left frontal region extending from eyebrow to the hair-line and from slightly beyond the middle line to 2 cm. beyond the outer canthus. There was a distinct "crinkly" sensation on pressure. Small amount of pus in the middle meatus. Left frontal sinus and right maxillary sinus dark on transillumination.

Roentgen Examination: Shows evident cloudiness of left frontal sinuses and right maxillary sinus in the anterior-posterior view. Note that the light line seen surrounding the normal right frontal sinus is not distinctly visible on the left. The lateral view shows absorption of the outer, bony wall of the frontal sinus. It is extremely thin and somewhat bulging, which is typical.

Diagnosis: Mucocele of left frontal sinus and chronic inflammation of right maxillary sinus.

FIGURE 351.

FIGURE 352.

Illustrations of Maxillary Sinus Infection and Cysts.

Figures 353A and 353B.

Patient: Miss A. H. P.

History: Complained of being in poor health. Was referred by her dentist for extraction of the left maxillary molars. During the extraction the maxillary sinus was opened and Roentgen examination of the sinuses was advised.

Roentgen Examination: A picture of the teeth on the left upper side, taken previous to the extraction, shows a large shadow, indicating extensive periapical infection around the apex of the first molar root (Figure 353*A*). The other two molars show signs of root-canal filling. On the right upper side there was also found to be extensive infection around the teeth. Figure 353*B* shows, on the left side, a completely radiopaque maxillary sinus and on the right side a radiopaque structure of definite shape and outline, suggesting a thin bony wall separating it from the upper part of the maxillary sinus, which is normal in density, compared with the shadow of the orbit.

FIGURE 353*A*.

Operative Findings: The right maxillary sinus was found to be filled with a periodontal cyst, originating from abscessed teeth in the maxilla. After the cyst membrane was removed, the bone cavity was found to be whole and to contain no outlet into the nose. The left sinus was filled with polypoid degeneration.

Figure 354.

Patient: Mr. W. H., Sr. No local history.

Roentgen Examination: Routine examination of the teeth and sinuses was made. The right maxillary sinus was found to contain a radiopaque structure with distinct outline, but without any bony wall separating it from the rest of the sinus cavity. A diagnosis of cyst in the maxillary sinus was made. The cyst was not due to a dental condition, as in the preceding case, but was probably of a nature similar to that shown in Figure 355.

FIGURE 353*B*.

FIGURE 354.

Illustrations of Cyst in the Maxillary Sinus and Unilateral Pansinusitis.

Figure 355.

Patient: Mrs. A. L. U.

Roentgen Examination: Shows a distinct radioparent mass in the right maxillary sinus. Its base appears to be attached to the outer wall of the sinus. It has a distinct outline, but light line bordering its structure. The remaining part of the sinus appears normal.

Operative Findings: A large flexible cyst containing mucogelatinous substance was found in the maxillary sinus. The lesion was enclosed only in a thin membrane.

Figure 356.

Patient: Mrs. M. J. (Courtesy of Dr. Francis P. Emerson.)

History: Had had measles in childhood and mastoiditis when thirteen years old. Two attacks of pyelitis, the last six months ago. Tonsillitis previous fall. Backache beginning again.

Examination: Polypoid degeneration in left ethmoids. Transillumination dark over entire left side. Tonsils show muco-pus. Deep cervical adenitis on left side.

Roentgen Examination: Referred to the writer for Roentgen pictures. The anterior-posterior view shown in Figure 356 reveals cloudiness of all the sinuses on the left side. A diagnosis of pansinusitis of the left side was made.

Operative Findings: Low-grade infection in ethmoid labyrinth and frontal and maxillary sinuses, following secondary polypoid degeneration.

FIGURE 355.

FIGURE 356.

VII. STONES IN THE SALIVARY GLANDS AND DUCTS.

Stones are not so commonly found in the salivary glands as they are in the gall-bladder or kidneys. They are more apt to be found in the sublingual and submaxillary glands and ducts than in the parotid gland, where they are of rare occurrence. It has not been absolutely settled whether these stones are formed secondary to infection, calcium phosphate and carbonate being deposited concentrically around emboli, leukocytes or organic exudates, or whether the infection which usually accompanies such cases is due to the irritating presence of the calculi.

The clinical picture is generally that of inflammation, and it is necessary to make a differential diagnosis for abscesses of dental origin. A roentgenogram of the inflamed, or swollen floor of the mouth will not only reveal any stone which may be present, but will also give some idea as to its location. Salivary stones, being composed mainly of calcium salts, are very radiopaque and are, therefore, easily recognizable in the Roentgen picture.

A large intraoral film is the best one to use if the stone is located in the floor of the mouth. It should be placed between the teeth as far back as possible. The patient's head should be bent to an extreme backward angle, so that the rays can be directed from the submandibular region to the film. If the stone is in the submaxillary gland itself, or in the parotid gland, extraoral plates will give the most accurate information.

VIII. LYMPHATIC INFECTION IN THE SUBMAXILLARY, SUBMENTAL AND CERVICAL REGIONS.

There are two groups of lymph glands which drain the jaws and teeth and their mucous membrane. The submental glands take care of the region of the mandibular incisor teeth. Of the three submaxillary lymph glands, the anterior one lies anterior to the external maxillary artery and is connected with the region of the superior incisors, cuspids and bicuspids; also the mandibular cuspids, bicuspids and first molars. The middle submaxillary lymph gland lies posterior to the external maxillary artery and drains the parts containing the

maxillary first molar, but also partly the maxillary bicuspids and second molar. In the mandible it takes care of the three molars, but principally of the second molar. The posterior gland is situated at the posterior pole of the submaxillary salivary gland and is connected with the maxillary third and second molars and also with the mandibular third molar, which is, to a small extent, drained by the middle gland.

Lymphangitis.—Lymphangitis is an inflammation of the lymphatic vessels, and also gives rise to inflammation of the tissue immediately surrounding them. It is rarely a primary condition and usually extends from the focus to the nearest lymphatic gland. Lymphangitis is caused by absorption of toxins and bacteria from an infectious focus, such as a periapical infection or other abscess in the mouth. (See case illustrated in Figure 363.)

Lymphadenitis or Adenitis.—Lymphadenitis or adenitis of the submental or submaxillary lymph glands is of very frequent occurrence and is often associated with dental or oral infections. The surgical removal of enlarged lymph glands should not be undertaken before ruling out dental infection.

Acute Lymphadenitis.—Acute lymphadenitis usually occurs in connection with acute focal infection. The glands become only slightly enlarged, feel soft and elastic and are very sensitive on palpation. The tissue surrounding the glands generally becomes infiltrated and the infection may break through the capsule of the gland and infect the surrounding tissue.

Chronic Lymphadenitis.—If the inflammation of the lymph gland does not promptly subside after removal of the cause, a chronic condition will result. The glands then usually become much larger, are hard, easily palpated and not tender to the touch. They are not adherent and seldom suppurate.

In all lymphatic inflammation the cause should be looked for and, if it is not obvious, a Roentgen examination is necessary to locate the primary infectious lesion (Figures 363 and 364). Generally the glands are not recognizable in a Roentgen picture, but if calcification of the diseased tissue has set in, the calcareous deposits are easily seen, as they are radioparent (Figure 365).

Illustrations of Salivary Stones.

Figure 357.

Patient: Mrs. C. A. P.

History: Patient stated that under the tongue there was a swelling, which varied in size and was usually largest before meal times.

Roentgen Examination: Shows a radiopaque object on the right side of the floor of the mouth opposite the first molar. Diagnosis of salivary calculus was made.

Operative Findings: An incision was made in the mucous membrane of the floor of the mouth, to expose the submaxillary duct and sublingual gland. The duct did not contain any stone, but the sublingual gland contained a salivary calculus, surrounded by a small amount of pus.

Figure 358.

Patient: Mr. G. G. F.

History: Had swelling under tongue, plica sublingualis was very much enlarged, and the day after the Roentgen exposure the condition was very much worse. The tongue was board-like and the entire floor of the mouth infiltrated. General appearance not unlike Ludwig's angina.

Roentgen Examination: Shows a large stone in the floor of the mouth. The stone is not compact and there are parts which look as if they were detached.

Diagnosis: Salivary stone with acute infection.

Operative Findings: Stone was found in sublingual gland and about two ounces of pus were evacuated from the abscess.

Figure 359.

Patient: Mr. R. B.

History: Swelling in region of right submaxillary gland for years. For two days previous to examination the condition had been very painful. Examination showed swelling the size of an egg in submaxillary region and swelling and inflammation under tongue.

Roentgen Examination: Shows salivary calculus in floor of mouth.

Operative Findings: Stone was found in submaxillary duct. Large amount of pus discharged after stone was removed.

Figure 360.

Patient: Mrs. E. G. H.

History: Patient had noticed swelling in left side of mandible, in submaxillary region, fifteen years before. This had occasionally increased in size, but had caused no pain. For two years the swelling had increased just before meal times and when pressure was applied saliva could be pressed into the mouth.

Roentgen Examination: Discloses large salivary stone three-quarters of an inch long.

Operative Findings: The stone was found in the submaxillary duct. It was badly discolored, of firm consistency and only a small amount of pus was discharged.

FIGURE 357.

FIGURE 358.

FIGURE 359.

FIGURE 360.

Illustrations of Salivary Stones.

Figures 361 *and* 362.

Patient: Mrs. H. E. M. (Courtesy of Dr. John T. Bottomley.).

History: Patient had tumor-like swelling on cheek and felt a hard substance under the skin, but no pain.

Roentgen Examination: Plates by courtesy of Dr. A. W. George. Two plates had to be taken to ascertain the location of the foreign bodies. From the lateral view, shown in Figure 361, one might think the radiopaque foreign bodies were located in the maxillary sinus, but the second plate shows that they are outside of the maxillary bone and from the location in both plates, we may conclude that they are in the parotid gland.

Operative Findings: The foreign bodies, after being removed, were found to be small lumps and felt like cartilage. Pathological examination showed them to be organized thrombi, which had become calcified. These phleboliths were concentrically arranged.

FIGURE 361.

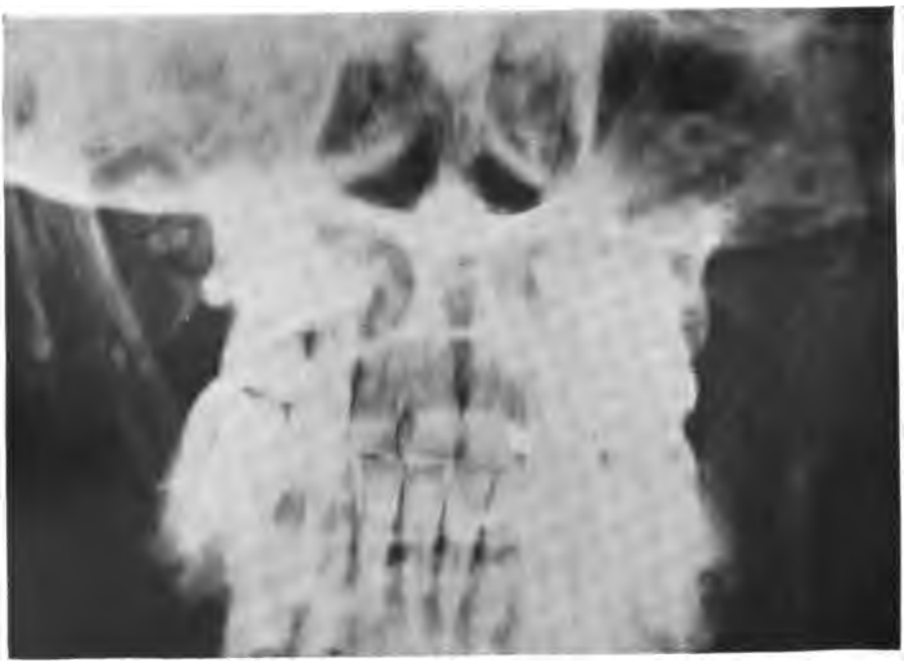


FIGURE 362.

Illustrations of Lymphatic Infection from Dental Cause.

Figure 363.

Patient: Mrs. I. B. C.

History: For several days red lines, indicating inflammation of the lymph vessels, were seen extending from the submaxillary region to the breast and axilla. The submaxillary as well as the cervical lymph glands were swollen. No pain of dental origin.

Diagnosis: Submaxillary and cervical lymphangitis.

Roentgen Examination: Shows dark shado v around the entire root of the right mandibular bicuspid. The tooth shows evidence of root-canal filling and there is lack of contact with the molar. Roentgen diagnosis of periapical infection and alveoloclasia was made, and this infection was believed to be the cause of the lymphatic condition, which disappeared entirely after extraction of the bicuspid and curettage.

Figure 364.

Patient: Mr. C. S. B.

History: Complained of tenderness under jaw. No pain and no other symptoms. Examination showed swelling of submaxillary lymph gland. A diagnosis of lymphadenitis was made.

Roentgen Examination: Roentgen examination of the molars on that side revealed a dark area of considerable size around the roots of the second molar. The dark area under the distal part of the filling indicates decay. On opening the tooth the pulp was found to be extremely putrescent. After treatment the glands again became normal.

Figure 365.

Patient: Mr. J. R., aged thirteen years.

History: Five years before had pain in a tooth on right side of the mandible. His dentist removed the pulp of the right mandibular first molar. After filling the root canals a swelling appeared under the jaw. At first this was soft and tender; later it increased in size and became hard.

Examination: Showed two hard lumps below the inferior border of the mandible. The larger anterior one was about the size of a walnut. The posterior one extended behind the angle of the jaw and was somewhat smaller. Both were easily movable.

Roentgen Examination: Shows the larger gland to contain numerous small particles of calcified tissue, which are extremely radiopaque. The posterior gland shows larger and fewer particles. The appearance of the mandible is normal. The third molar is partly formed and not yet erupted. The first molar shows evidence of root-canal filling, but no definite signs of periapical infection.

FIGURE 363.

FIGURE 364.

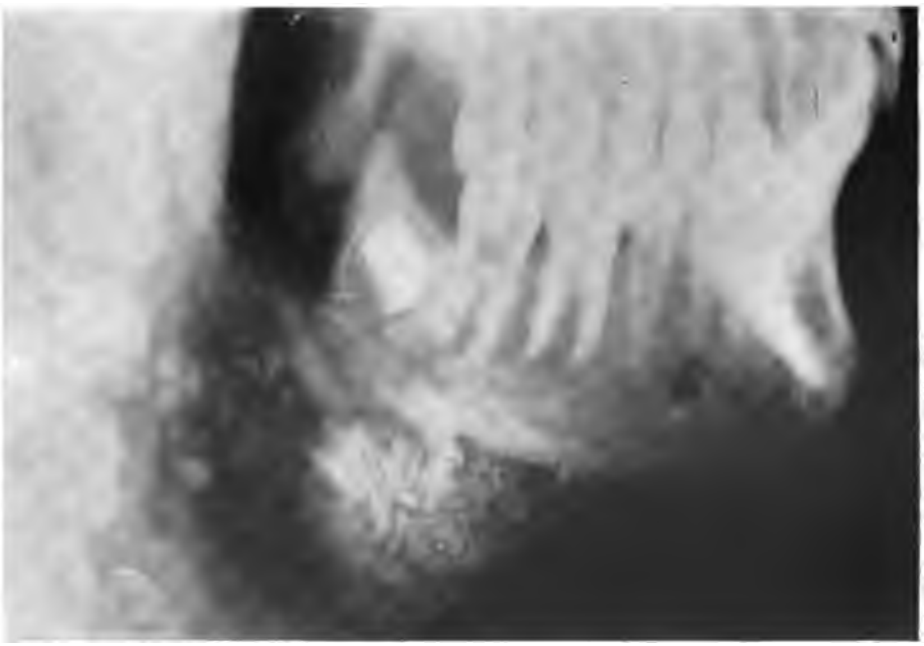


FIGURE 365.

PART V.

THE USE OF ROENTGENOGRAMS AS AN AID IN TREATMENT.

WHILE the Roentgen examination is of inestimable value in the diagnosis of abnormal and diseased conditions, it is an almost indispensable aid in certain therapeutic processes such as root canal work, apicoectomy and the setting of fractured jaws. It is a great help to have a roentgenogram before any treatment is started, as a correct diagnosis is the first step in determining the necessary therapeutic method, and often saves the patient a great deal of time and annoyance. The progress of treatment can be followed step by step, up to the final result.

I. THE TREATMENT OF ROOT CANALS.

Accurate root-canal treatment and filling has presented perhaps the greatest difficulty in dentistry, principally because without a roentgenogram the dentist works in the dark, trying to treat a condition which has not been properly diagnosed. If we know the correct size, length and direction of the root canals and their abnormal pulpal and periapical condition, we can more easily accomplish the desired result. Poor root-canal fillings are found in the mouth of almost every adult.

From examining many thousands of roentgenograms the following general conclusions may be drawn from the result of root-canal operations performed without the aid of the Roentgen method.

A very small percentage of pulpless teeth have completely filled root canals. Of these, some show an entirely normal condition of the periapical tissues, as far as one is able to judge from a perfect Roentgen picture, while others reveal decided periapical changes, notwithstanding

the fact that the whole canal, as far as the apex, may have been filled. Whether such conditions are due to periapical infection having occurred before the root-canal operation was performed and having persisted, or whether they represent an infection which took place during or after the filling of the canal cannot be ascertained. Figure 366 is the Roentgen picture of a tooth with a perfect root-canal filling, done twenty-one years ago. The periapical tissue appears normal. Figure 367 shows a tooth with a perfect root-canal filling and periapical infection.

A number of Roentgen pictures disclose the fact that accidents occurred during the root-canal operation. The most frequent ones are caused by motor-driven root-canal instruments. They may be due also to miscalculation of the direction of the canal, or to bent roots. Figure 368 illustrates a case with a perforation in the lateral incisor. Broken root-canal instruments may also be discovered, as they are generally of steel and show up very distinctly, on account of the radiopacity of the metal (Figures 371 to 373).

Poor root-canal fillings, on account of anatomical conditions, or calcifications obstructing the canal, are not so frequently found as those due to faulty technic, which will be considered later. In this class belong bent roots (Figure 375), and canals filled with calcareous deposits (Figure 374).

By far the largest percentage of poor root-canal fillings are caused by improper and careless technic, and because before the use of the Roentgen ray there was no means of telling whether the operation was successful or not. No doubt in most cases the work was done as well as possible under the circumstances, but today there is no excuse for working in the dark. A small percentage of partly filled root-canals show no periapical infection (Figure 376). Whether this is due to perfect sterilization and aseptic methods, or to antiseptic preparations used in connection with the filling cannot be determined by the Roentgen method. The majority of teeth with poor and incomplete root-canal fillings show involvement of the periapical tissue, affecting not only the peridental membrane, but also the tooth tissue and the bone. Roentgenograms disclosing partial, cork-screw and poorly-condensed fillings are presented in (Figures 377 to 380.)

Prognostic Roentgen Examination before Removing Pulps from Normal Teeth.—A knowledge of the etiology of periapical infections and a realization of the uncertainty of root-canal fillings denotes the importance of careful consideration of the roots and root canals by means of roentgenograms before deciding on pulp removal from a normal tooth. The apical part of the tooth presents many variations and decided curves at the very end. We frequently find one or more accessory foramina, and the number of the root canals is not as constant as one might be led to believe from the older text-books on dental anatomy. Two canals are frequently found in mandibular bicuspids; even three occasionally, while the mandibular cuspids and incisors quite often have bifurcated canals leading to a common foramen. The mandibular molars sometimes have two canals in each root, and the third molars are, of course, always uncertain (Figures 196 to 203).

The dentist who extirpates the pulp of one or more teeth to restore masticating efficiency by bridge work renders poor service if periapical infection develops and systemic complications follow.

Prognostic Roentgen Examination of Pulpless Teeth which are to be Treated.—It is of great importance to make sure of the probable outcome before involving the patient in lengthy root-canal treatment and before using pulpless teeth as abutments for expensive prosthetic appliances. If the roentgenogram shows slight and recent involvement of the periapical tissue the condition can usually be improved, if not healed, by root-canal treatment and filling to the apex, but if there is indication of extensive bone destruction due to an abscess or granuloma, if the apex is found to be necrosed, or if the side of the root is perforated, the tooth, as a rule, cannot be restored to normal by root-canal treatment alone. It should either be extracted or receive surgical treatment directed toward the periapical disease, that is, apicoectomy, or root amputation.

Sometimes cases are seen which received root canal treatment for months when a roentgenogram would have shown at once a surgical disease which never could have been affected by root-canal medication, nor by electrolytic treatment. Such cases are cited in the sections where their pathology and diagnosis are discussed.

The Use of the Roentgen Ray as a Guide in Root-canal Cleaning and Filling.—The importance of removing every particle of pulp tissue, especially if diseased, from the canal or canals of a tooth, has only recently been fully realized. It is also imperative for the canal to be properly reamed and enlarged, either by mechanical or chemical means, and for the apical foramina to be hermetically sealed by means of suitable root-canal fillings. The only safe way to determine whether a canal is properly prepared for successful filling is by means of the Roentgen ray. If the operator has a Roentgen machine by his chair he can insert broaches of the right size and take a picture with the rubber dam in place (Figures 384–388). The rubber dam clamp, however, should be removed and replaced by ligatures, so as not to confuse the picture. If the film is to be taken at some future time, or in a different place, fine wires, with looped ends and containing the antiseptic dressing, should be placed in the canals, after which the cavity should be sealed (Figure 382). This process ought to be repeated until the Roentgen picture shows that the wires extend to the very ends of the canals. After the root canal is filled, another roentgenogram should be taken, and in case the filling does not reach the apex of the root, or each of the roots, it should be removed and replaced by a perfect one. Different types of root-canal fillings are shown in Figures 389 to 394.

Checking up Pulpless Teeth by the Roentgen Method.—It is highly commendable to take roentgenograms of pulpless teeth at certain intervals to find out whether they remain normal, or become absorbed and cause bone infection. If a slight periapical infection existed when the root canal was treated, the tooth should again be examined after six months and after one year, to ascertain whether the bone changes have been repaired. If this is found to be the case, the indication is that the tooth is sterile and is being tolerated by the system.

II. APICOECTOMY.

Prognostic Roentgen Examination.—Before undertaking apicoectomy on a tooth, the condition should be carefully studied. With the aid of a roentgenogram, observe the shape of the root and the extent of

the abscess cavity. If too much of the root has to be excised, there will not be enough alveolar process left to hold it firmly after the operation. A tooth with alveoloclasia is, for the same reason, not favorable. Neither should a tooth be operated upon if there is another infection in the immediate neighborhood, as this would, directly or indirectly, reinfect the healing tissue (Figures 395 and 396).

Checking up of the Different Steps.—Proper root-canal treatment and sterilization is the first step in apicoectomy. The operation can only be successful if future infection is prevented by sterilization of the root canal and dental tubules. Roentgenograms are used in the manner described for root-canal treatment to check-up the different steps. The final one, showing the extent of the root-canal filling, gives an idea of the length of the root, will show the position of the neighboring teeth and the extent of the abscess cavity (Figures 404 to 421).

Following up the Healing Process.—A Roentgen picture should be taken immediately after the operation, not only to make sure of the result, but also to afford a record of the Roentgen appearance of the bone cavity at this stage. Successive pictures, taken every six months, show the progress of bone repair. After six months bony bridges can be seen, and after a period of from eighteen months to two years, varying according to the age of the patient, the process of repair is usually completed (Figures 404 to 418).

III. THE TREATMENT OF FRACTURED TEETH.

It is a very common accident for children to fracture the anterior teeth when romping. When a horizontal fracture near the root end is discovered in a roentgenogram, the writer has found excision of the root apex a very satisfactory procedure. The root canal of the remaining part of the tooth must, of course, be treated beforehand. A case in which the two maxillary central incisors were fractured near the apex is shown in Figures 422 to 424, taken before and after treatment. In another case, where it was advisable to remove the fractured tooth, a porcelain tooth was carved, the shape of the root conforming to the outline of the tooth socket, and inserted into the wound when the injured tooth was removed (Figures 419 to 424).

Illustrations of Condition of Periapical Tissues when Root Canal is Completely Filled.

Figure 366.

History: Root canal of tooth had been filled twenty years before.
Roentgen Examination: Shows root canal filled to apex; periapical tissue normal.

Figure 367.

History: Root canal had been filled several years before.
Roentgen Examination: Shows root canal filled to apex; large area in periapical region indicating infection and apical absorption.

Illustrations of Accidents During Root-canal Treatment.

Figure 368.

History: Accident during root-canal treatment.
Roentgen Examination: Shows perforation at distal side of lateral incisor. The dark channel was probably made by a burr, or root-canal reamer.

Figure 369.

Roentgen Examination: Mesial side of cuspid has a perforation, through which the post of a porcelain crown protrudes. The root canal had been filled previously, but when enlarging the canal for the post, the direction must have been misjudged.

Figure 370.

Roentgen Examination: Shows that the root of the first bicuspid has been perforated at the mesial side and that the filling protrudes into the alveolar bone.

Figure 371.

Roentgen Examination: Shows a radiopaque object in the root canal of the maxillary first bicuspid. This was found to be a piece of a broach.

Figure 372.

Roentgen Examination: Shows in the apex of the lateral incisor, a small radiopaque object, which appears much lighter than the root-canal filling and, therefore, must be metal.

Figure 373.

Roentgen Examination: A radiopaque object in the distal root canal of the first molar was found, which proved to be the point of a root-canal drill.

FIGURE 366.

FIGURE 367.

FIGURE 368.

FIGURE 369.

FIGURE 370.

FIGURE 371.

FIGURE 372.

FIGURE 373.

Illustrations of Normal and Abnormal Conditions of Root Canals.

Figure 374.

Roentgen Examination: Shows that the apical half of the root canal of the lateral incisor is completely obliterated by calcareous deposits.

Figure 375.

Roentgen Examination: Shows maxillary first and second bicuspids with bent roots.

Illustrations of Condition of Periapical Tissues when Root Canal is Partly Filled.

Figure 376.

History: Pulp had been removed and tooth filled many years before.

Roentgen Examination: Shows second bicuspid with root canal only partly filled, and apical as well as periapical tissues normal.

Figure 377.

Roentgen Examination: Shows a maxillary central incisor with partial root-canal filling and normal periapical tissue.

Figure 378.

Roentgen Examination: Shows partial filling of root canal of maxillary cuspid, the dark area at apex indicating periapical infection.

Figure 379.

RoentgenExamination: Shows partial root-canal filling of cork-screw type in lateral incisor.

Figure 380.

Roentgen Examination: Shows partial root-canal filling, apex unfilled and space between filling and wall of root canal.

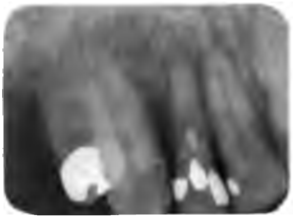


FIGURE 374.

FIGURE 375.

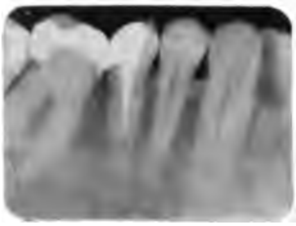


FIGURE 376.

FIGURE 377.

FIGURE 378.

FIGURE 379.

FIGURE 380.

Illustrations of the Use of the Roentgen Ray as a Guide in Root-canal Cleaning and Filling.

Figures 381 to 383.

Figure 381 shows lateral incisor and cuspid with partial root-canal fillings.

Figure 382 shows wires inserted, indicating that the ends of the canals have been reached.

Figure 383 shows new root-canal fillings.

Figures 384 to 388.

Figure 384 shows mandibular first molar. Note the slight change in the bone surrounding the apices. This, indicating pathology, leads to the conclusion that the pulp is infected.

Figure 385 was taken with a rubber dam ligated into place and a broach inserted into the distal canal.

Figure 386 shows broaches in two canals of the mesial root, indicating that the end has been almost reached.

Figure 387 shows three broaches inserted in the canals of the molar. These extend to the very ends.

Figure 388 shows the completed root-canal fillings.

FIGURE 381.

FIGURE 382.

FIGURE 383.

FIGURE 384.

FIGURE 385.

FIGURE 386.

FIGURE 387.

FIGURE 388.

Illustrations of Different Types of Root-canal Fillings.

Figures 389 *to* 394.

Figure 389. *Roentgen examination* shows the root canal of the central incisor properly filled with a small excess of chloropercha, which went through the apical foramen.

Figure 390. *Roentgen examination* shows a root-canal filling previous to apicoectomy. Chloropercha was pressed through the foramen into the granuloma. (See Figures 262 and 263 for picture after apicoectomy had been performed and after the wound had healed.)

Figure 391. *Roentgen examination* shows root-canal filling in lateral incisor with excess forced into periapical tissue.

Figure 392. *Roentgen examination* shows the root-canal filling of a maxillary central incisor. Note the accessory canal and the excess of gutta percha beyond both apical foramina.

Figure 393. *Roentgen examination* shows the corkscrew type of root-canal filling in a mandibular bicuspid.

Figure 394. *Roentgen examination* shows the filling replaced with a small excess of soft chloropercha outside of the foramen.

FIGURE 389.

FIGURE 390.

FIGURE 391.

FIGURE 392.

FIGURE 393.

FIGURE 394.

Illustrations of Teeth not Suitable for Apicoectomy.

Figures 395 *and* 396.

Figure 395. *Roentgen examination* shows a dark area extending almost to the cervical margin of the alveolar process; also marginal alveoloclasia. There would not be sufficient support for the tooth if all the pathological tissue were removed.

Figure 396. *Roentgen examination* shows the abscess cavity extending to the alveolar crest. This case is similar to the preceding one.

Illustrations of Attempted Apicoectomy.

Figures 397 *and* 398.

Figure 397. *History:* Patient said that an apicoectomy had been performed on the first mandibular molar.

Roentgen examination shows that the apical part of the mesial root had been separated, but not excised.

Figure 398. *History:* Apicoectomy on maxillary cuspid.

Roentgen examination shows no healing of bone cavity and apex of tooth not removed.

Illustrations Showing Progressive Stages of Apicoectomy.

Figures 399 *to* 403.

Figure 399. *Roentgen examination* shows condition after apicoectomy on both mandibular central incisors. The dark shadow around the ends of the roots indicates the cavity in the bone, caused by the removal of the two apices, the abscess tissue and whatever loss of bone was caused by the operation.

Figure 400. *Roentgen examination* shows the condition before the operation.

Figure 401. *Roentgen examination* shows wires in the root canals to indicate the extent to which they have been cleaned.

Figure 402. *Roentgen examination* shows the new filling in the root canals.

Figure 403. *Roentgen examination* shows the condition after apicoectomy has been performed. The dark shadow at the apices is the bone wound caused by removal of the tooth apices and inflammatory granulation tissue.

FIGURE 395.

FIGURE 396.

FIGURE 397.

FIGURE 398.

FIGURE 399.

FIGURE 400.

FIGURE 401.

FIGURE 402.

FIGURE 403.

Illustrations Showing Healing after Apicoectomy.

Figures 404 *to* 407.

Patient: Mrs. M.

Figure 404 shows an abscess caused by a necrotic pulp.

Figure 405 shows the root canal treated and filled.

Figure 406 shows the condition after apicoectomy was performed.

Figure 407 shows the progress of the healing after eight months. Bony bridges can be seen in the cavity, which in Figure 406 is entirely dark.

Figures 408 *to* 411.

Patient: Mrs. W.

Figure 408 shows a maxillary cuspid with root-canal filling, and condition of periapical tissues before the operation.

Figure 409 shows the condition after treatment and filling of the root canal.

Figure 410 shows the condition after the operation.

Figure 411 shows new bone formation nine months after the operation.

FIGURE 404.

FIGURE 405.

FIGURE 406.

FIGURE 407.

FIGURE 408.

FIGURE 409.

FIGURE 410.

FIGURE 411.

Illustrations Showing Healing after Apicoectomy.

Figures 412 *to* 414.

Patient: Miss D.

Figure 412 shows root canal of central incisor filled, apparently by the old method, the points not having been dissolved in chloroform and resin placed in the canal. Note the abscess area.

Figure 413 shows condition after the operation.

Figure 414 shows the bony wound entirely filled in, after fourteen months.

Figures 415 *to* 418.

Patient: Miss B.

Figure 415 shows condition immediately after apicoectomy was performed on the maxillary lateral and central incisors.

Figure 416 shows progress of the healing after two months.

Figure 417 shows progress of the healing after ten months.

Figure 418 shows the bony wound entirely filled in after two years.

FIGURE 412.

FIGURE 413.

FIGURE 414.

FIGURE 415.

FIGURE 416.

FIGURE 417.

FIGURE 418.

Illustrations of Fractured Teeth.

Figures 419 *to* 421.

Patient: Mr. R. S. C.

History: Patient was hit with a hockey stick and the right maxillary central incisor was loosened.

Roentgen Examination: Shows evidence of fracture (Figure 419).

Operation: The two fragments were removed (Figure 420), and with the roentgenogram as a guide, a porcelain dummy was carved to be attached to the left central incisor, by means of a staple crown, the porcelain root to fit exactly into the alveolar socket. It was inserted immediately after removing the fractured root (Figure 421).

Figures 422 *to* 424.

Patient: Master P. P.

History: Three or four weeks previous to the examination he had injured both maxillary central incisors. A fistula had formed over the right incisor.

Roentgen Examination: Shows the apices of both central incisors fractured in a horizontal plane.

Operation: A splint was attached to the lingual surfaces of the four incisors and the root canals filled, after which apicoectomy was performed on each tooth, removing the apical fragment. Figure 422 shows the left root canal filled. Figure 423 shows the root canals of both teeth filled and apicoectomy performed on the right central incisor. Figure 424 shows both roots amputated and progress of healing after four months.

FIGURE 419.

FIGURE 420.

FIGURE 421.

FIGURE 422.

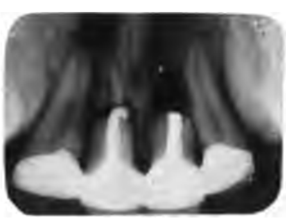


FIGURE 423.

FIGURE 424.

IV. ORTHODONTIA.

Complete Roentgen Examination.—Complete Roentgen examination before undertaking orthodontic treatment is of the greatest value in all cases where there are deciduous teeth present, or when the permanent teeth are not all erupted. Abnormally slow decalcification of the roots of the deciduous teeth can often be recognized and in such cases extraction is indicated to prevent late eruption of the permanent tooth, or its growing in a wrong direction. If the deciduous teeth have been shed and the permanent teeth have not come into place the Roentgen examination may reveal that they are malposed or entirely absent. In older children it is also necessary to find out whether there are pulpless teeth present, and whether the periapical tissues are normal or infected. Any of these conditions may mean a change in the method to be used for restoring normal occlusion.

Artificial Tooth Eruption.—Frequently, in favorable cases, especially in younger people, unerupted teeth can be artificially erupted. After locating the exact position of an unerupted tooth, by means of the Roentgen method, the gum and bone overlying the tooth is excised so that part of the enamel is exposed. The tissue is then cauterized and packed with rubber tissue. After forty-eight hours the packing may be removed and, if proper care is taken, without causing any bleeding. A small loop of platinum wire is then cemented into a hole drilled into the tooth. To this may be attached an extension from the orthodontia arch wire, by means of which gradual force is applied until the tooth is moved into its normal position. (For case reports see Figures 429 to 436.

V. DENTAL RECONSTRUCTION.

A careful, systematic study of crown and bridge work proves that in the average case very little attention is paid to the condition of the teeth, or roots, which are used as abutments. The problem is, by many, regarded as a purely mechanical one, simply to restore the masticating efficiency and the appearance, and any tooth which is useful as a mechanical support is retained, without investigation of its

condition. This short-sightedness often makes it necessary to destroy bridges of very recent construction, in order to remove an abutment which is causing extensive periapical infection, or to treat the root canal of a tooth in which the pulp has become infected (Figures 437 to 441).

Roentgen Diagnosis before Planning Reconstruction.—Before undertaking any artificial restoration the teeth which are to be used as abutments should be carefully roentgenographed. Better still, a complete Roentgen examination should be advised, because often unsuspected conditions in other parts of the mouth are discovered, which, although they may not require immediate attention, should be considered so that it will not be necessary later to undo the work.

The Pulp of the Bridge Abutment.—Since our better knowledge of the pathological conditions, both local and systemic, so frequently caused by pulpless teeth, we have been impressed with the seriousness of pulp extirpation. Whenever possible, restoration should be made without sacrifice of the pulps in normal teeth. If, however, the pulp has become involved from decay, or if there is danger that pathological processes may start after the bridge is made, it is, of course, better to determine whether root-canal treatment is advisable. The various steps in the root-canal treatment should be checked-up by means of other pictures, as already described. It is a mistake to believe that a tooth must have its pulp removed before a gold or porcelain jacket crown can be attached to it. The writer has seen many roentgenograms of teeth which were perfectly normal after carrying crowns for a long time. Figure 446 shows a maxillary bicuspid with a gold crown which has been on the tooth more than ten years without causing any pathological condition. Figure 147 shows two jacket crowns, one on a cuspid and one on a bicuspid, both the teeth having normal pulps. If pulp disease is present it may have started when the tooth was prepared, or chronic infection of the pulp or periapical tissues may have existed before the crown was made. Again, the pulp disease may have been caused by decay starting under poorly-fitting crowns and unclean bridges, or from improper root-canal work.

Technical Construction.—Faulty construction of crowns or bridges can easily be demonstrated in Roentgen pictures, especially such conditions as overhangs, poor fit at the cervical margin, surplus of cement remaining in the gingival crevice, etc. If special strain is exerted on the abutment of a root it may either cause alveoloclasia (Figure 448), or, on account of an effort of Nature to supply more strength, condensing ostitis may occur, causing thickening of the lamina dura of the alveolar socket. The stimulation may also extend to the cementoblasts at the tooth surface, causing hypercementosis (Figure 449).

Illustrations of Orthodontia Cases.

Figures 425 *to* 428.

Patient: Mr. F.

History: Some of the deciduous molars were retained an abnormally long time, with no sign of the permanent bicuspids coming.

Roentgen Examination: Shows that in the maxilla there is no sign of the bicuspids and that the left maxillary cuspid is growing in an oblique direction. In the mandible, where both first bicuspids are partially erupted, the second bicuspids are missing. Note that the roots of the deciduous molars have been absorbed, although the permanent teeth are absent.

Figures 429 *to* 431.

Patient: Mr. W. W. R.

History: Left maxillary cuspid is missing.

Roentgen Examination: Figure 429 shows the unerupted tooth. It appears to be impacted over the apex of the lateral incisor. An attempt at artificial eruption was made. Figure 430 shows the loop wire attached to the crown of the unerupted tooth after exposing it from the palatal side. The tooth, however, could not be moved, on account of its impaction. Figure 431 shows that no progress had been made ten months later.

FIGURE 425.

FIGURE 426.

FIGURE 427.

FIGURE 428.

FIGURE 429.

FIGURE 430.

FIGURE 431.

Illustrations of Artificial Tooth Eruption.

Figures 432 *and* 433.

Patient: Mr. B. J. (Courtesy of Dr. Alfred P. Rogers.)

History: Right maxillary cuspid missing and no sign of its approaching eruption.

Roentgen Examination: Showed that it was unerupted and in an almost horizontal position.

Operation: The tooth was exposed at the palatal surface, after which Dr. Alfred P. Rogers undertook its orthodontic care. Figure 432 shows the case a few days after he had the orthodontic appliance attached. The extension wire which applies the force is attached to a loop cemented into the crown of the tooth. After nine months the tooth was almost in its proper position, as shown in Figure 433.

Figures 434 *to* 436.

Patient: Mr. R. E.

History: (Courtesy of Dr. Adelbert Fernald.) Patient received orthodontic treatment.

Roentgen Examination (Figure 434)*:* Made by the writer, shows a supernumerary cuspid on the left and an unerupted cuspid on the right, the cusp of the tooth being placed behind the apex of the central incisor root.

Operation: The cuspid crown was exposed and made ready for artificial eruption (Figure 435). Dr. Fernald started the orthodontic treatment at once. He inserted a loop into the cusp of the tooth for the application of the force. Figure 436 shows the cuspid pulled down nearly into place.

FIGURE 432.

FIGURE 433.

FIGURE 434.

FIGURE 435.

FIGURE 436.

Illustrations of Bridges Attached to Teeth, the Condition of Which was not Ascertained.

Figures 437 *to* 441.

Patient: Mr. W.

History: All the bridges and crowns shown in the Roentgen films had been constructed a very short time before.

Roentgen Examination: Shows evidence of periapical infection on a great many teeth. In the left side of the maxilla there is evidence of extensive periapical infection on the first bicuspid (Figure 437). On the left side of the mandible the cuspid, a bridge abutment, and on the right side the first and second bicuspids all show extensive periapical infection (Figures 439 and 440). In the incisor region (Figure 441) there are two more teeth with considerable periapical destruction. It is apparent from the size of the bone cavities that these conditions must have existed at the time when the work was done.

FIGURE 437.

FIGURE 438.

FIGURE 439.

FIGURE 440.

FIGURE 441.

Illustrations Showing the Use of the Roentgen Ray in Dental Reconstruction.

Figure 442.

Patient: Miss N.

History: Had a feeling of pressure in left side of the maxilla, the lateral incisor being very sore. A bridge replacing the missing cuspid had been made very recently. Patient consulted a dentist, who advised removing the pulp of the lateral incisor, or taking off the bridge.

Roentgen Examination: Shows both bicuspids and the lateral incisor vital. Apparently an unerupted cuspid is causing pressure on the root of the lateral incisor.

Figure 443.

Patient: Mr. I. V. W.

History: Complained of occasional soreness of the central incisor.

Roentgen Examination: Shows an unerupted, impacted cuspid.

Figure 444.

Patient: Mr. H. K. B.

History: Inflammation of gum under the bridge and a fistula which was discharging pus.

Roentgen Examination: Shows two roots beneath bridge, and evidence of infection in the bone surrounding them.

Figure 445.

Patient: Mr. P.

History: Swelling on gum.

Roentgen Examination: Shows that under the bridge are a molar and first bicuspid roots, which are apparently the cause of the infection.

Figure 446.

History: Gold crown had been on maxillary first bicuspid over ten years. Pulp vital.

Roentgen Examination: Shows entirely normal periapical tissue.

Figure 447.

History: The maxillary first and second bicuspids had borne jacket crowns for three years. Pulps vital.

Roentgen Examination: Shows no change in periapical tissues.

Figure 448.

Patient: Mr. H. P. H.

History: Had a bridge made to replace maxillary first molar. Examination showed that the cusps of the bridge were too prominent, giving it lateral motion.

Roentgen Examination: Shows a root under the bridge and alveoloclasia around the entire root of the second bicuspid. This is associated with periapical infection.

Figure 449.

Patient: Mr. J. S.

History: Patient stated that bridge was too short and that the dentist malletted it into position.

Roentgen Examination: Made three years after bridge was inserted. Note thickening of the lamina dura and hypercementosis at apex of root of mandibular first bicuspid.

FIGURE 442.

FIGURE 443.

FIGURE 444.

FIGURE 445.

FIGURE 446.

FIGURE 447.

FIGURE 448.

FIGURE 449.

PART VI.

EXAMINATION OF THE ORAL CAVITY.

THE method of examination of the mouth, as practised by the average dentist, is thoroughly inadequate. As a rule, little pains are taken to consider the mouth as a whole, and even in localized conditions there is a tendency to try various methods of treatment before ascertaining the cause and exact nature of the trouble. It is extremely unwise to jump at conclusions. The most proficient diagnosticians seldom depart from a systematic plan of examination, and it is always well to adopt a certain routine and follow it in every case.

History.—Inquire into the patient's general health, for it must be borne in mind that the teeth are not isolated organs, but are in immediate relation to other important structures, and closely associated with the rest of the body. The mouth may be the seat of secondary lesions of general diseases such as the eruptive fevers, tuberculosis and syphilis and, on the other hand, infectious lesions in the mouth may be the primary or contributory cause of somatic disturbances. If there is some special local condition of which the patient complains, an exact history should be taken.

Physical Examination.—The mouth should then be inspected, the condition of the teeth being noted first to see whether they are healthy or neglected, or whether they show signs of dental work, either good or poor. The lips, cheek, palate and gums and throat should be examined next. Inflammatory changes, swellings and fistulæ should be looked for.

Roentgen Examination.—Unless it is evident that the teeth are perfectly healthy and that there are no large fillings, crowns or bridges, a Roentgen examination is indicated. A patient seen for the first time,

or any patient whose teeth have never been roentgenographed, should have a routine examination; that is, pictures of all the teeth. If this is systematically carried out, one will often be surprised to find definite diseased conditions on teeth which would have been passed by in a superficial examination. Indications of decay under fillings, or of cavities under the gums, are frequently discernible; unerupted teeth may be discovered, and the condition of root-canal fillings and status of pulpless teeth are disclosed. Alveoloclasia, due to faulty contact points, overhanging fillings and other mechanical irritations, becomes clearly visible, together with its cause, and in periodontoclasia valuable information can also be gathered as to the amount of bone destruction and deposit of serumal calculi in the pockets. The Roentgen examination is also of value in leading to the discovery of other conditions, which cannot be definitely demonstrated in the picture, but the appearance of which arouses suspicion and indicates the necessity for further clinical study.

The pictures, after completion, should be mounted on a film-mount designed to hold the entire set, so that the mouth may be viewed as a whole.

Diagnosis.—A diagnosis should be made only after careful consideration of the conclusions arrived at by means of the various examinations. In bone diseases the Roentgen method is, perhaps, the most important means of examination, but it should always be remembered that a Roentgen picture is not a diagnosis. It gives evidence, which should be correlated with the history, physical findings, tests and laboratory findings.

I. EXAMINATION FOR FOCI OF INFECTION IN THE ORAL CAVITY.

In any infection we have both local and general effects. The general effects in acute infection are easily recognized clinically at the very beginning, as they come on suddenly, are well marked and sometimes even alarming. The local condition is also readily perceived. In chronic infection, however, the systemic effects are very mild at their onset and may not cause any great harm if the protective forces

of the body are able to take care of the condition. When, however, the general resistance becomes lowered by debilitating disease, poor physical condition, pregnancy, exposure, or malnutrition, serious complications may gradually develop, so gradually that frequently the patient is not aware of the systemic disease until irreparable harm has been done. Locally the manifestations of the chronic focal lesion are generally not noticed, and in some parts of the body even the physician or dentist can find them only by most careful Roentgen examination.

To show how different an effect the same disease may produce in a perfectly normal body and one in which the resistance has been lowered by chronic disease, the following observation of two patients may serve as an illustration. The first, a woman with a perfectly healthy heart, and the other, a patient with a weak heart, both had the same amount of vaccine injected. The first patient, a well-developed and well-nourished woman, had been suffering from chronic arthritis for twenty-one months. Lungs, normal; heart sounds, regular and of good quality. When using vaccine treatment injection of 75,000,000 typhoid bacteria with 100 cc of normal salt solution was made at 3.30 P.M. into the basilic vein. She had a definite chill, which lasted twenty minutes, but otherwise there were no heart symptoms. Temperature and pulse curve shown on chart in Figure 450. By 9.30 P.M. these were perfectly normal. A second vaccine treatment of 100,000,000 bacteria, given eight days after, produced a similar result.

The second patient, a woman, aged thirty-six years, was admitted to the hospital for chronic arthritis. She had had measles, diphtheria and scarlet fever when a child; at the age of twelve, "St. Vitus dance," which lasted two years; two attacks of pneumonia when fifteen years old and rheumatic fever seven years previous to admission. Present illness had begun eighteen months before, when she had noticed pain and stiffness in the knees. The joints of the fingers, elbows and shoulders then became involved. Present examination showed slight edema in ankles, teeth poor, glandular enlargement in submaxillary region on both sides. There was a systolic murmur of the heart, but no evidence of physiological disease. At 4.15 one afternoon the

patient received a vaccine injection intravenously of 75,000,000 bacteria. At 5 P.M. there were signs of reaction, chill, typical spasmodic shaking, but no complaint of cold. Had marked cardiac symptoms at 9 P.M. Patient was dyspneic, cyanotic and coughing. Sputum was salmon colored. Distress, dyspnea and headache lasted until about midnight and the next day there was still tenderness and palpitation over the precordia.

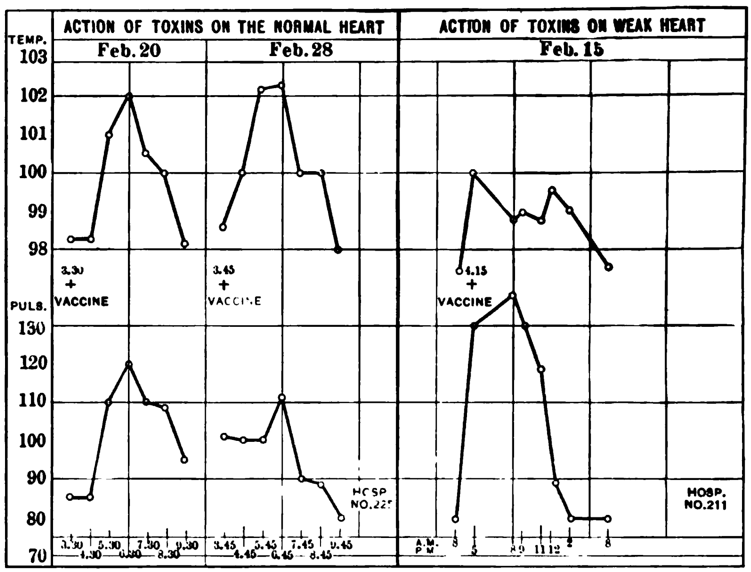


FIGURE 450.

The healthy patient, in this case the one with the strong heart, could easily withstand the slight infection, while the other, whose resistance was lowered, suffered most severe effects (see chart, Figure 450).

Foci of Infection in General.—The focus may be found in any part of the body, but the nose or throat and adjacent sinuses, the oral cavity, alimentary canal and genito-urinary system are the parts in which foci are most frequently found. Foci are not always apparent and are often only recognized after very careful examination by the specialist.

Oral Foci of Infection.—It is a mistake to spread the impression that diseases of the mouth and teeth always play a predominant part, as much as it is a mistake to think that the mouth and teeth and their investing tissues are organs apart from the rest of the body, reacting, for some mysterious reason, differently from the rest of the human organism. The various oral lesions which may become foci of infection are described in Part V. Pulp and periapical infections, periodontoclasia, periodontal cysts and sinus disease, with a few less frequent bone infections, are the conditions most commonly connected with systemic disease.

When such infectious lesions are found it is still necessary to determine whether they represent an original focus, or one of several from which bacteria have migrated to other organs, or in which toxins have been produced and absorbed, or whether the dental infections and the systemic conditions are simply coexistent and not directly related to each other. These questions must be considered individually for every case. Positive statements cannot be made with absolute certainty, as to the probable benefit of removing the focus. The secondary lesion or disease may be of such long standing that the removal of the original focus has but little effect. The secondary lesion may not have received proper attention, or because the tissue changes are so extensive that restoration to the normal cannot be expected. The best results are obtained in cases of short duration, and especially in those where the secondary disease is due to toxemia, rather than to bacterial migration. After finding oral lesions in a patient who complains of symptoms caused by diseases conceded to be due to focal infection, the patient should first be carefully examined by an internist. It is for him to decide the nature of a given case and whether focal absorption of toxins or bacteria may be an etiological factor.

Another aspect of this problem is the question as to whether it is perfectly safe for an otherwise healthy patient to retain teeth which, on account of their chronic character, cause no local disturbance, but which show infectious processes at the ends of the roots when roentgenographed. While there is little doubt in most cases as to what should be done with badly infected teeth, there are, nevertheless, cases where

we should like to recommend and try more conservative methods if we could be sure that no absorption was taking place. Where apical necrosis and absorption of long standing are discovered in the Roentgen picture, indicating clearly that Nature wants to eliminate an obnoxious foreign body, extraction is indicated, from a purely dental point of view. No one who has studied the tooth and bone pathology of old pus-soaked teeth, or who has experienced the odor of one which has been removed, would ever hesitate to recommend extraction, simply for the sake of cleanliness. But in cases of short standing, especially in younger patients, treatment and retention of a tooth would seem advisable if the roentgenographic indications are favorable to root-canal work.

In patients suffering from some chronic disease, or whose resistance is lowered, radical treatment is generally indicated. It is perfectly justifiable to be radical in such cases, not only with diseased, but even with suspicious teeth, although they may not be the direct cause of the general condition. A perfectly healthy body can take care of a certain amount of toxin, but the same amount in a patient suffering, for example, from subacute endocarditis, may produce serious results. In chronic disease the hopeful therapeutic measure lies in improving the functional efficiency of the body and building-up the general health.[1] To further this end it is important to remove all necrotic tissue, because the organs whose function it is to combat disease must be freed from any additional burden.

Special and General Diseases which may Originate from Oral Foci of Infection.—In compiling and classifying special and general diseases due to oral infection, the writer has aimed to include only such diseases as are, at the present time, generally conceded to be caused by focal infection, and of which cases have been observed and published in sufficient number to establish without doubt their relationship. It should be clearly understood that all these conditions may arise from a focus in any part of the body and that diseases of the teeth are not

[1] McCrudden, F. H.: The Treatment of Chronic Disease is a Problem of Applied Physiology. Boston Med. and Surg. Jour. Vol. **175**, No. 2.

the only etiological factors, nor even the most important, although they are generally the least carefully diagnosed.

Laryngology, Rhinology and Otology.—Maxillary sinusitis in its various clinical forms is often caused by dental infections. However, in cases which are clearly of nasal origin, pulpless and infected teeth may become a contributory cause which, if not removed, will prevent complete recovery. Tonsillitis and pharyngitis may occur from pus discharged into the mouth. Ear infections, such as acute otitis media or chronic purulent inflammation of the middle ear and tympanum may be caused by direct invasion through the Eustachian tube, or the infection may be transported by the circulation. Pain in the ear, so-called otalgia dentalis, is frequently only a reflex pain from some other cause in or about the teeth.

Ophthalmology.—Disturbances in the eye may be brought about by nerve irritation, or through hematogenous or direct infection. Infectious conjunctivitis in children is often caused by rubbing the eyes with the fingers, which have been put into the mouth to feel an aching tooth with pus discharge through a fistula. The pus may get on the child's fingers and be brought into contact directly with the eyes. Hematogenous infection may lead to infection of other parts of the eye, causing iritis and retrobulbar neuritis.

Pediatrics.—Children are frequently victims of focal infection causing grave and sometimes irremediable conditions, such as heart disease (endocarditis), kidney disease (nephritis) and acute inflammation of the joints. Acute or chronic lymphadenitis is also a common occurrence in children.

The importance of removing infectious lesions in cases of endocarditis, even if not the original cause of the disease, is illustrated in the following case, where decided improvement resulted from the extraction of two teeth, the toxic absorption from which prevented response to the ordinary treatment.

The patient, Hospital Case No. 116, aged thirteen years, had had measles when very young and scarlet fever seven years before admission. He had never had any sore throat. Seven years before present examination he started to have pain in the joints, mostly in the shoulder

region, associated with fever. Shortly afterward he complained of pain over the precordia and of dyspnea upon exertion. He was kept in bed except for meals. Physical examination showed lungs negative, heart apex visible and palpable in fifth interspace, 11 cm. from the midsternum. Over the apex was felt a distinct presystolic thrill; sounds were of fair quality, but rapid; at mitral area a presystolic murmur was heard; over aortic area there was a diastolic murmur and over the pulmonic area a systolic murmur. Patient was admitted to the hospital November 6. Temperature 100.6° F,, pulse 140, respirations 28, blood-pressure $\frac{125}{80}$. He was put on a light diet and kept in bed. Roentgen examination of his teeth showed abscesses at the

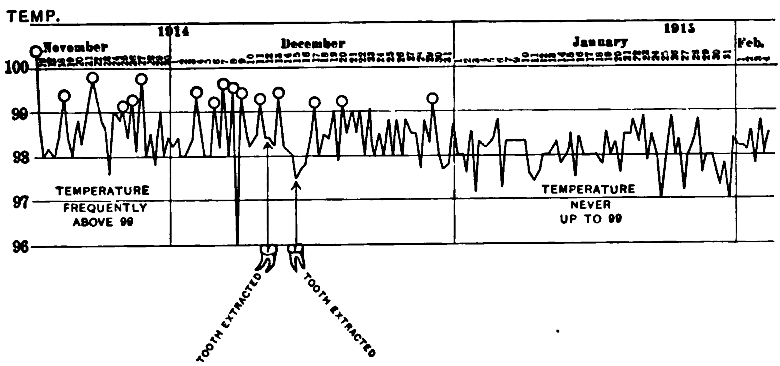


FIGURE 451.

roots of the two mandibular first molars. The first was extracted on December 11 and the other on December 14. After this the temperature was only three more times over 99° F. in December and in January it was never up to 99° F. From the time he was admitted until the time he received dental treatment, December 11, the temperature was quite frequently above 99° F., as indicated by the circles (Figure 451).

General Medicine. — Septicemia and pyemia may be caused by infections from the teeth, but are of comparatively rare occurrence. Toxemia, however, is more frequently observed. Many obscure troubles are due to absorption of a small amount of toxin. Such symptoms may be fatigue disproportionate to the slight exertion occa-

sioning it, inability to do the accustomed day's work, mentally or physically, benumbed mental activity, requirement of an abnormal amount of rest, loss of weight, grayish or sallow skin, and a rise of temperature in the afternoon or evening. A person who is perfectly healthy may be able to eliminate a certain amount of infection, but sooner or later serious results are apt to occur. Lowering of the body temperature by cold or wet may give rise to more or less vague rheumatic symptoms in the muscles (myositis), joints (arthritis), or nerves (neuritis). Cases of acute multiple arthritis from dental infections are not uncommon and generally improve rapidly after removal of the focus. In chronic infections, especially arthritis of long standing, the results are not so gratifying. The joints may present tissue changes which are beyond repair from an anatomical point of view. The removal of the focus, however, usually relieves symptoms of pain and swelling and prevents reinfection from this cause.

Endocarditis and Nephritis.—Endocarditis and nephritis are also caused in the adult by transported infection from a focus. In heart infections there is the additional danger of damage due to absorption of toxin from any infectious lesion, not necessarily the cause of the disease.

Lymphatic Infections.—Absorption through the lymphatic channels occurs both from acute and chronic dental infections. Lymphangitis and lymphadenitis are sometimes produced in serious forms. According to Professor Cantani, tubercular infection of the submaxillary lymph glands, independent of general tuberculosis, is often caused from entrance of the tubercle bacillus through a root canal, spreading *via* the lymphatic vessels. He reported fifty clinical observations.[1]

Gastro-intestinal Disorders.—Gastro-intestinal disorders are frequently caused by pus from the nasopharynx or mouth being swallowed into the stomach. According to many writers the most common disturbances are septic gastritis, appendicitis, colitis and gastric and intestinal ulcers.

[1] Cantani, Arnoldo: La Clinica Italiana, June and July, 1914.

II. ROENTGEN EXAMINATION OF THE TEETH IN DENTAL NEURALGIA.

The extensive area of distribution of the trifacial nerve and its frequent communications with other cranial nerves and the sympathetic system, explains the clinical manifestations that pain and irritation, originating from some dental or oral cause, may be referred to very distant parts of the face and head, including the ear (otalgia dentalis), the eye, the nose and accessory sinuses. Such pain may be continuous, intermittent or periodic; it may be intense, sharp, throbbing or dull, and it may be a sensation of obscure, indefinable pressure. The suffering that goes with these conditions is often intense and, if of sufficient duration wears the patient out. It sometimes results in more serious nervous disorders, such as insomnia, melancholy and epilepsy.

The cause is often difficult to ascertain and it is necessary to make a very careful study of the history and symptoms, combined with physical examination and tests and a careful Roentgen examination, not only of the teeth on the affected side by intraoral films, but also of the entire side of the face.

Undetected dental caries, with or without pulp involvement, is one of the frequent causes. Caries under a filling, or on the surface of a tooth beneath the gum, may be discovered by means of a Roentgen picture (Figures 181 to 185).

Dental neuralgia is often attributed to pulp calcifications and pulp nodules. The writer has seen several cases of this type (Figures 205 to 208). One should, however, rule out other possible causes before deciding to sacrifice the pulp of a tooth, as these pulp nodules are very often simply coexistent and have nothing to do with the cause of the pain.

The dentinal branch of the nerve, before entering the tooth apex, often becomes inflamed, especially in teeth from which the pulps have recently been removed, or in cases of periapical infection. The writer has successfully treated several such cases by apicoectomy.

The larger peripheral nerve trunks may become inflamed from

irritation or infection of a tooth, or after extensive surgical interference. Such a neuritis generally lasts several weeks and is sometimes associated with paresthesia of the part supplied anterior to the injury. This is, of course, only temporary and is due to pressure exerted by the wall of the nerve canal in the bone upon the nerve, which has increased in size.

Chronic parietal abscesses, especially between the three roots of a maxillary molar, where recognition is difficult even with good roentgenograms, may cause prolonged suffering. The teeth may be vital and not sensitive to percussion. Periclasia, especially if caused by poor restoration, may be found to be at the root of a neuralgic affection.

Unerupted and impacted teeth are very commonly the cause of obscure neuralgia expressed in varying ways, as has been mentioned in the special section dealing with those cases. The neuralgia may be due to pressure against the obstructing tooth or bone, sometimes causing pressure absorption and pulp exposure on the tooth against which they lie, or to pressure of developing roots against the nerve trunk. Such teeth may lie dormant for a long time and then suddenly start to exert pressure. This period of rest and activity is generally repeated at irregular intervals (Figures 123 and 124).

III. ROENTGEN EXAMINATION IN CASES OF TRIGEMINAL NEURALGIA, OR TIC DOULOUREUX.

Trigeminal neuralgia, or tic douloureux, is not caused by any condition of the teeth. Its etiology and pathology are unknown. Any of the pathological conditions described may be coexistent with it, but their removal will never cure a real trifacial neuralgia. If this were borne in mind and the symptoms of the disease, which are quite different from those of dental neuralgia, recognized in time, many of these poor sufferers would be spared the loss of valuable teeth.

The characteristic symptoms which differentiate trigeminal neuralgia from the foregoing type are well described by Silverman.[1] The patient is usually middle-aged, or older, complains of sharp lancinating

[1] Silverman, S. L.: Trigeminal Neuralgia, Nat. Dent. Jour., 1921.

pains, or severe burning flashes which shoot through some area supplied by any of the branches of the trigeminal nerve. The subject has suffered for a year or more—he may have a premonitory aura not unlike that found in epileptics. When such an aura is present the patient can sometimes ward off the attack. The alteration of facial expression, accompanied by a ghastly stare is very characteristic in these cases. The patient may explain that a tooth, or some other area supplied by the fifth nerve, will, when touched, cause severe paroxysms of pain. Talking or laughing is likely to bring it on. Washing, rubbing, shaving, powdering, or having the bed covers touch the area is sufficient to elicit the pain. In fact a draft of air or the alighting of a fly may bring on the attack. One characteristic which is paramount, however, is that the patient will invariably state that the pain is the most excruciating of all pains.

These cases should be recognized by their history and distinguished from dental neuralgia, where the roentgenogram will reveal a definite cause, and its removal relieve the pain permanently. It is often difficult to convince patients suffering from trifacial neuralgia that the tooth in which they think the trouble is located is not the cause of the pain. This is true even when they have had one after another extracted. Always it is the next tooth in line, until all are gone, and still the pain persists. The patient is then without teeth and, on account of the disease, or its treatment (alcohol injection or nerve avulsion), finds it more difficult to wear a denture than the normal person.

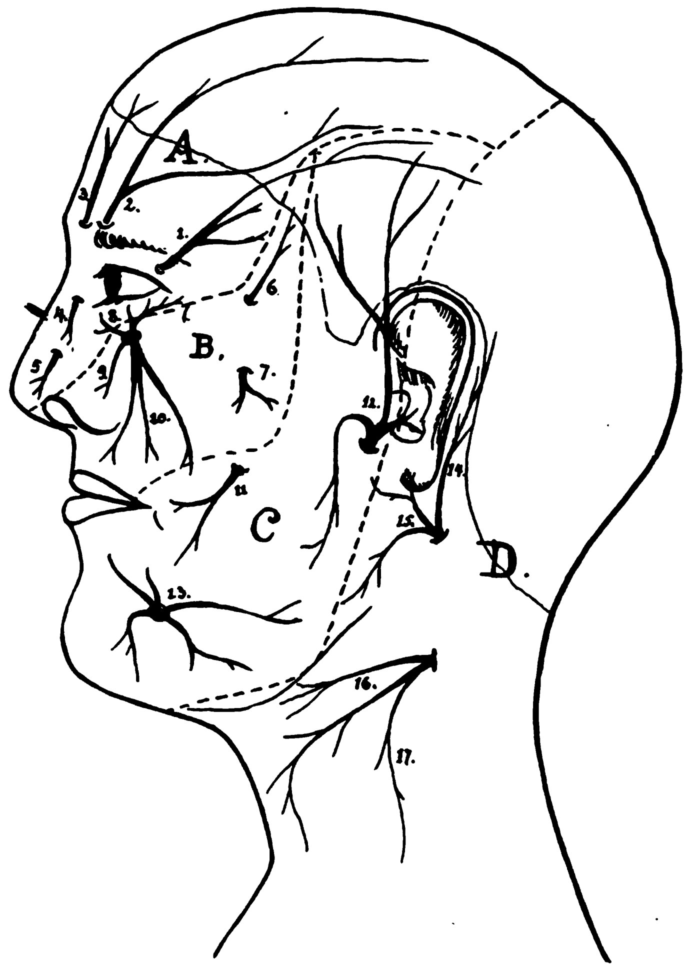


FIGURE 452

Illustration of Nerve Endings on Outside of Face which form Starting Points.—*A*. Supplied by 1st division of *V*. *B*. Supplied by 2d division of *V*. *C*. Supplied by 3d division of *V*. *D*. Supplied by cervical nerves. 1. Lachrymal. *N*. 2. Supraorbital *N*. 3. Supratrochlear *N*. 4. Infratrochlear *N*. 5. Ext. nasal *N*. 6. Zygomatic-temp. *N*. 7. Zygomatic facial *N*. 8, 9, 10. Palpebral, nasal and labial branch of infraorbital *N*. 11. Buccinator *N*. 12. Auriculotemporal *N*. 13. Mental *N*. 14, 15. Post. and ant. great auricular *N*. 16, 17. Sup. and inf. cutaneous Coli. *N*.

Illustrations of Cases of Oral Foci Causing Systemic Disease.

Figures 453 *to* 456.

Patient: Mr. G. T. S.

History: Had completely broken down with rheumatic fever and suffered from intermittent attacks of conjunctivitis of the left eye for several years. Lost a great deal of weight and for several months had been unable to attend to his duties.

Clinical Examination: Mouth showed that the teeth were loose and discharged a great deal of pus. The gums were highly inflamed.

Roentgen Examination: Large pockets on all the teeth. The left mandibular molar, as seen in Figure 455, shows entire destruction of the bone around the mesial root, including the interradicular septum and involving the pulp of the tooth.

Result of Operation: After extraction of all the diseased teeth the patient improved rapidly and in seven weeks gained about fifty pounds.

Figure 457.

Patient: Mr. D. G.

History: Five weeks before being referred to the writer the patient began to have rheumatic swellings and pains in the knees. The shoulders were next attacked and in a short time all the large joints became involved. He took electric baths, but without result. When he came for examination of the mouth, he was walking on crutches and was in great pain, although he had no pain whatever in the face or mouth.

Roentgen Examination: Shows indication of periapical infection on a maxillary incisor and molar (Figure 457). The maxillary sinus was suspected and a Roentgen picture showed distinct cloudiness.

Operative Findings: The sinus was opened, revealing a chronic infection with inflammatory tissue, caused by the molar, which was extracted.

Result of Operation: Patient first suffered exacerbation due to the surgical autoinoculation and had to stay in bed for a few days, not being able to use his joints. He then started to improve and after seven weeks was entirely rid of his arthritic symptoms.

FIGURE 453.

FIGURE 454.

FIGURE 455.

FIGURE 456.

FIGURE 457.

Illustrations of Cases of Oral Foci Causing Systemic Disease.

Figures 458 *and* 459.

Patient: Mr. T. R., middle-aged man.

History: Had been in the best of health for several years, but complained that recently he had had symptoms of toxemia, which manifested themselves in benumbed mental activity, a feeling of grogginess upon rising, etc. Smoking made him ill, whereas he had been able to smoke a great deal before.

Roentgen Examination: Of the teeth showed periapical infection on the right maxillary lateral incisor (Figure 458) and the left maxillary cuspid and two bicuspids (Figure 459).

Treatment and Results: At first the teeth were opened to be treated through the root canals. A vile odor came from the canals. The patient improved during the treatment, but got worse again after the canals were filled. Permanent relief resulted, however, after all necrotic tissue had been removed by surgical treatment.

Figure 460.

Patient: Miss P., a young college student.

History: Consulted the writer about a tooth which had been treated. She complained of a tired feeling and frequent, intermittent fever. The condition had lasted eight months, without improvement. There were no other symptoms and no local discomfort in the mouth.

Roentgen Examination: Shows the right mandibular molar, a pulpless tooth, and the bicuspid without evidence of root-canal treatment, but with a large shadow at the apex, indicating bone infection.

Operative Treatment and Result: After extraction and removal of the chronic inflammatory granulation tissue the patient improved rapidly and the temperature remained normal.

FIGURE 458.

FIGURE 459.

FIGURE 460.

Illustrations of Cases of Oral Foci Causing Systemic Disease.

Figures 461 *to* 470.

Patient: Mr. G., a chauffeur.

History: Had been having pain in the back and shoulders, which incapacitated him for his work. Roentgen examination of the shoulders and spine revealed no bony changes. He had had a careful physical examination and no cause was found, to which his trouble might be attributed. A complement-fixation test of the blood showed 3+ reaction to hemolytic streptocci, 3+ to Streptococci viridantis and 3+ to the colon bacillus. The skin test reacted positively to hemolytic streptococci, Streptococci viridantis and pneumococci. No skin test was made for the colon bacillus.

FIGURE 461.

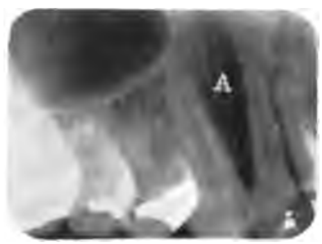


FIGURE 462.

FIGURE 466.

FIGURE 467.

Illustrations of Cases of Oral Foci Causing Systemic Disease.

Figures 461 *to* 470 *Continued.*

Roentgen Examination: Figures 461 to 470 show evidence of periapical infection on many teeth. Those considered to be the most important foci are marked A to D. Besides these there are a number of other pulpless teeth with but little evidence of bone infection. Alveoloclasia at the mesial side of the cuspid is marked L.

Result of Operation: After extraction of the infected teeth and curettage, from which pure cultures of Streptococci viridantis and hemolytic streptococci were obtained, the patient improved rapidly, so that he was able to work again very soon. He is now driving a truck and has been free from symptoms ever since the operation, two years ago.

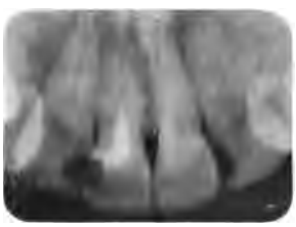


FIGURE 463.

FIGURE 464.

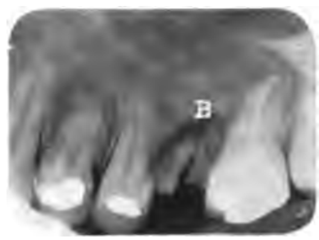


FIGURE 465.

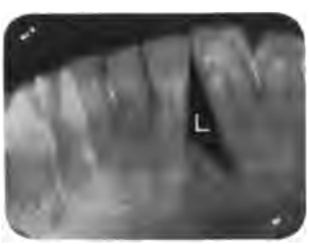


FIGURE 468.

FIGURE 469.

FIGURE 470.

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